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Screwworm

Minutes of the Meeting Held with National Council on Science and Technology (CONACYT) to Discuss the Vegetation Map of Veracruz Project

Institutions represented at the meeting:

National Commission on Outer Space
Commission on National Territories Studies.
Mexico-North American Joint Commission for the Erradication of the Screwworm.
The Biological Institute of Universidad Nacional Autonoma de Mexico (UNAM).
National Council on Science and Technology, represented by its Tropical Ecology Agency.

The meeting was opened by Dr. Arturo Gomez-Pompa, explaining that the principal purpose of this meeting was the desire by CONACYT, through its National Tropical Ecology Agency, to evaluate the project by UNAM to carry out research in the State of Veracruz to work out a vegetation map of said State in collaboration with NASA. The interest expressed by NASA to work out a map of the actual vegetation of this State has the concurrence of the Botanical Department in Veracruz of the Biological Institute of UNAM. It is thought that NASA's interest can be utilized as the best possible way to carry out this project.

Since NASA has mentioned that their interest in working out this map is connected with their studies on screwworm research, and since all of the information connected with this project has not been made sufficiently clear, this matter was referred to CONACYT to hold this meeting to obtain in greater detail the opinions of the different groups interested in a project of this nature. It was especially desired to contact those persons who have had experience in collaborating with NASA and to learn the effects of such experience from such collaboration.

Dr. Gomez-Pompa explained that interest does exist by him and his research group to carry out this project; however, he feels that such studies do not necessarily have to be carried out exclusively with NASA, but can be carried out in an independent manner.

Consideration was given that perhaps it would be convenient to have the participation of NASA in this project, but that it did not necessarily have to be carried out under its direction.

It was stated that the cooperative agreement sent by NASA essentially specified the collaboration of the Biological Institute under Dr. Arturo Gomez-Pompa, and included the possibility of having two individuals from Mexico go to Houston to acquaint them in more detail with the technologies--computer technology as well as details in working out vegetation maps based on materials and information which has been obtained through the satellites.

Personnel from the Computer Center of the Universidad Nacional Autonoma de Mexico (UNAM) were also invited since it is considered that someone in the field of computers should be sent in order to obtain more knowledge of the

techniques being utilized in resource inventory studies with remote sensing.

Dr. Villasenor of the Mexican-American Commission on the Erradication of the Screwworm spoke extensively on the current status of the projects carried out under this program, commenting on the negative and positive points of such project, and emphasizing on some of the problems that should be taken into consideration in future agreements with NASA. Among the most important points stated by Dr. Villasenor was the fact that once these agreements were finalized and were executed, they were not necessarily complied with by the personnel from NASA. This especially applies when scientists who are connected in one way or another with the projects enter into Mexico but little is known of their projects or programs. He gave some very clear examples on these problems; one was in relation to some new insecticide trails held in Tamaulipas, and another was in relation to the possibility of having Mexican pilots participate in flights for NASA projects. In both cases there were problems which caused confusion and in the end, very little information was available to Mexico in this respect. He emphasized the necessity of having better national communications among the different interested groups and the necessity of carrying out a more efficiently coordinated research program.

Dr. Gomez-Pompa thanked Dr. Villasenor for his comments and indicated that this was precisely the things they needed to know in order to avoid falling into similar problems.

Dr. Martin del Campo commented on some events connected with the Agreement which was signed with Mexico and further commented that it would be well to make known to the parties of the Agreement, and especially to the Department of Exterior, all the abnormalities derived from these problems in relation to the activities of the foreign scientists in Mexico.

He indicated the growing necessity on the part of Mexico to have certain control concerning the activities of the foreign scientists in Mexico; however, he also expressed concern over the difficulty involved in carrying out a plan of this nature.

Dr. Gomez-Pompa mentioned that this aspect is very important and has been considered with great preoccupation by the National Council of Science and Technology with their different offices, agencies and departments. He stated that the group of investigators under his supervision in the remote sensing program have received offers of collaboration on similar projects from various universities in the United States relating to remote sensing applications for inventory of natural resources. It was mentioned that it would be very important to have standard policies for consideration of all solicitations which are of interest to Mexico.

Ing. Higuera Mota of the National Commission of Outer Space presented the Commission's points of view and indicated it would be very advantageous for any technician involved in remote sensing programs or investigations of this type to learn what is being conducted in Mexico in this respect; and for this reason, the National Commission of Outer Space is offering some courses in this regard and is actually carrying on a training program to train Mexican technicians in this type of methodology. He stated that if there have been coordination problems in the past, many of these problems can be explained, and that what is more important is to bear in mind the need for

effective coordination since there exists the signed agreement between the National Commission of Outer Space and NASA, and it would be very desirable to have any other similar agreement fall within this general agreement.

Ing. Higuera Mota offered all kinds of assistance by his agency for this new project connected with the studies of vegetation in Veracruz.

Dr. Martin del Campo commented that a distinction be made between projects and specific research programs dealing exclusively in the service phase, since in the case of the National Commission of Outer Space the basic service which they offer is in relation to obtaining information, data, photographs, flights, and the training of technicians, which does not necessarily relate directly with specific research programs which he feels should maintain their individuality.

Ing. Hector Alonso, representative from the Commission on Studies on National Territory, indicated that he has been pursuing with a great deal of interest the development of the investigations on the earth's resources being conducted by NASA with their satellites, and they are interested in collaborating or participating in projects of this type. He manifested he would like to know which is the specific project of NASA for Veracruz with the purpose of considering their possible participation.

Dr. Gomez-Pompa said that his agency's position in respect to NASA is that the research project concerning the vegetation map of Veracruz should be a totally Mexican project. This proposal shall be presented to NASA in order to explore their degree of participation and collaboration, knowing that actually they are interested. Nevertheless, he emphasized that this should be a factor to guide their work towards the future because the priorities given to international cooperative research programs should be in conjunction with Mexico's interest and projects, and not to the contrary. In the meantime, during the following weeks a detailed proposal shall be worked out to carry out this project, as soon as the possibilities are known for participation of other Mexican entities, organizations, institutions, or individuals. This proposal shall be presented to NASA. He also indicated that the possible collaboration with NASA should be with the object of obtaining some benefit from the participation, and such benefit might be the obtaining of information and new methods and techniques in this field.

The representative from the Commission on Studies of National Territories, Ing. Hector Alonzo, indicated that his agency would be very interested in participating in this project even though Veracruz would probably not be photographed until next year; nevertheless he indicated that they are very willing to actively participate during any stage of the project.

Ing. Higuera Mota from the National Commission of Outer Space concurred with this proposal and stated that the proposal could be presented at the next InterSecretarial Meeting to the different Secretaries of State to determine their interest in the project and also attempt to obtain greater collaboration or interest from other government agencies.

Dr. Gomez-Pompa stated that there definitely exists interest by various Secretaries of State and Commissions, such as the Federal Electric Commission of the Laguna Verde Project in Veracruz, the Office of Hydraulic Resources in the north and south part of Veracruz, as well as the Commission on Papaloapan having jurisdiction of all of the area covered by the Papaloapan River basin, which involves a great part of the State of Veracruz.

There were several discussions concerning the clearing up of some points in order to be able to carry out the project, and discussions on the importance of coordinated efforts in this field. A suggestion was made for weekly meetings in order to analyze the different projects and current status of the cooperative research programs with NASA. There were different opinions on this--for and against it. It was decided that the next meeting would be held for the presentation of the proposal on the vegetation map of Veracruz and at that time dates would be set to discuss some of the specific research problems.

It was agreed to hold a meeting with CONACYT to evaluate the screwworm research work that is being carried out in Mexico by the National Tropical Ecology Agency. This agency could take charge of coordination of this type meetings, overseeing that the different interested groups on this matter are contacted. It was suggested that a meeting be held as soon as possible to evaluate the current screwworm research situation and the participation of the Mexican institutions in said program.

All agreed to a next meeting with anticipation and the representative to be contacted for the National Council of Science and Technology would be Dr. Jorge A. Vargas from the Office of International Affairs. There being no further business, the meeting adjourned.

Mexico, D. F., October 18, 1974.

Dr. Arturo Gomez-Pompa

Dr. Enrique Martin del Campo

LISTA DE PERSONAS ASISTENTES A LA REUNION CELEBRADA EN
EL CONACYT PARA TRATAR EL PROYECTO "MAPA DE VEGETACION
DE VERACRUZ" EL 18 DE OCTUBRE DE 1974.

1. DR. ARTURO GOMEZ POMPA
Vocal Ejecutivo del Programa Nacional de Ecología Tropical
Depto. de Botánica del Instituto de Biología, UNAM.
2. M. en C. MAGARITA SOTO ESPARZA
Instituto de Biología, Depto. Botánica, UNAM
3. BIOL. FERNANDO MENENDEZ L.
Instituto de Biología, Depto. Botánica, UNAM
4. DR. MARCO A. VILLASEÑOR
Comisión México-Americana para la Erradicación del Gusano Ba-
rrenador
5. DR. RUBEN CASTILLEJOS GUIZAR
Comisión México-Americana para la Erradicación del Gusano Ba-
rrenador.
6. SR. PABLO RAMOS LEMUS
Comisión México-Americana para la Erradicación del Gusano Ba-
rrenador.
7. ING. HECTOR ALONSO E.
Comisión de Estudios del Territorio Nacional
Secretaría de Presidencia
8. ING. RAMON CARDOZA V.
Comisión de Estudios del Territorio Nacional
Secretaría de Presidencia
9. ING. RAUL HIGUERA MOTA
Comisión Nacional del Espacio Exterior
10. ING. SERGIO PADILLA GUZMAN
Comisión Nacional del Espacio Exterior
11. DR. ENRIQUE MARTIN DEL CAMPO
Director de Asuntos Internacionales, CONACYT
12. DR. JORGE A. VARGAS
Dirección de Asuntos Internacionales, CONACYT

MINUTA DE LA REUNION CELEBRADA EN EL CONACYT PARA
TRATAR EL PROYECTO "MAPA DE VEGETACION DE VERACRUZ"

Instituciones representadas en la Junta:

Comisión Nacional del Espacio Exterior.

Comisión de Estudios del Territorio Nacional.

Comisión Mixta Mexicano Norteamericana para la Erradica-
ción del Gusano Barrenador.

Instituto de Biología de la UNAM

Consejo Nacional de Ciencia y Tecnología por medio de su
Programa de Ecología Tropical y de la Dirección de Asun-
tos Internacionales.

1º.- La reunión se abrió con la intervención del Dr. Artu-
ro Gómez-Pompa, explicando que el motivo principal que genera esta jun-
ta es el deseo del CONACYT a través de su Programa Nacional de Ecolo-
gía Tropical de evaluar el proyecto de la UNAM de llevar a cabo un estu-
dio en el Estado de Veracruz, tendiente a la elaboración de un mapa de la
vegetación de dicho Estado en colaboración con NASA. El interés por ela-
borar un mapa de la vegetación actual de ese Estado expresado por NASA
es compartido por el Programa Flora de Veracruz del Instituto de Biolo-
gía de la UNAM. Se ha pensado que el interés de NASA pudiera ser uti-
lizado para llevar a cabo este proyecto a su realización en la mejor for-
ma posible.

Debido a que NASA mencionó que su interés por la elaboración

de este mapa está ligado a los estudios que vienen realizando sobre el gusano barrenador y debido a que toda la información concerniente a este proyecto no ha sido lo suficientemente clara, se recurrió al CONACYT para convocar esta junta y conocer con mayor detalle la opinión de diferentes grupos interesados en un proyecto de esta naturaleza. Especialmente se deseaba poner en contacto a aquellas personas que han tenido ya experiencia de colaboración con NASA y conocer la experiencia de esta colaboración.

El Dr. Gómez-Pompa explicó que existe interés por parte de él y de su grupo de investigación, en realizar dicho estudio, sin embargo, no necesariamente dicho estudio puede llevarse a cabo exclusivamente con NASA sino que podría llevarse a cabo en forma independiente.

Se consideró que quizá sería conveniente tener la participación de NASA en este proyecto, más no necesariamente que lleve la directriz del estudio.

Se mencionó que el proyecto de convenio que envió NASA especificaba fundamentalmente la colaboración del Instituto de Biología a través del Dr. Arturo Gómez-Pompa y se incluía la posibilidad de dos personas por parte de México para ser enviadas a Houston para conocer con mayor detalle las técnicas, tanto de computación como de elaboración de mapas de vegetación con base en los materiales disponibles provenientes de las informaciones obtenidas por los satélites.

Se invitó también a personas del Centro de Cálculo de la Universidad Nacional Autónoma de México, ya que también se ha pensado en poder enviar a alguna persona en el campo de computación para conocer más sobre las técnicas que utilizan para estudios de inventarios de recursos vía sensores remotos.

2° .- El Dr. Villaseñor de la Comisión Mexicano-Norteamericana para la Erradicación del Gusano Barrenador, hizo una amplia exposición de la situación actual de los proyectos relacionados en este programa de investigación, indicando los puntos positivos y negativos de dicho proyecto y haciendo hincapié en algunos problemas que debieran tomarse en cuenta para futuros convenios con NASA. Entre los puntos más importantes que destacó el Dr. Villaseñor, estaba el hecho de que una vez que los convenios se realizaban, y se firmaban, no necesariamente eran obedecidos por parte del personal de NASA. Esto es especialmente válido para la internación a México de científicos que en una forma u otra están relacionados con los proyectos, pero de cuyos programas y trabajo poco se sabe. Puso algunos ejemplos muy claros sobre este problema, uno en relación al ensayo de insecticidas especiales nuevos en Tamaulipas y otro en relación a la posibilidad de participación de pilotos mexicanos en los vuelos de trabajo de NASA. En ambos casos hubo problemas que causaban confusión y al final de cuentas poca información se tenía en México al respecto. El hizo especial énfasis sobre la necesidad de tener un mayor contacto nacional entre los diversos grupos interesados y poder llevar a cabo una eficien-

te coordinación de los programas de investigación.

3°.- El Dr. Gómez-Pompa agradeció al Dr. Villaseñor su intervención e indicó que precisamente esta era una de las cosas que deseaba conocer el nuevo proyecto, con el objeto de evitar caer en problemas similares.

4°.- El Dr. Martín del Campo hizo una intervención, mencionando algunos antecedentes relacionados con el convenio que se firmó para este efecto por México e hizo el comentario de que sería muy conveniente hacer conocer a las partes firmantes, en especial a Relaciones Exteriores, todas las anormalidades derivadas de estos problemas relacionados con las actividades de los científicos extranjeros en México.

Indicó la creciente necesidad por parte de México de poder tener un cierto control en relación a las actividades de los investigadores científicos extranjeros en México, sin embargo, expresó también su preocupación por la dificultad de llevar a cabo un programa de esta naturaleza.

5°.- El Dr. Gómez-Pompa mencionó que este aspecto es especialmente importante y esto ha sido visto por el CONACYT con bastante preocupación a través de diferentes oficinas, proyectos y programas; citó el caso de que para el programa de sensores remotos, el grupo de investigación que él tiene a su cargo, ha recibido ofrecimientos de colaboración de proyectos similares de varias universidades de los Estados Unidos, en

este campo de sensores remotos aplicados a inventario de recursos naturales. Se mencionó que sería sumamente importante poder presentar un frente común a todas estas solicitudes que interesen a México.

6° .- El Ing. Higuera Mota de la Comisión Nacional del Espacio Exterior presentó los puntos de vista de la Comisión que él coordina e indicó que es sumamente conveniente que cualquier técnico que se involucre en programas de sensores remotos o trabajos de este tipo, conozca lo que en México se hace al respecto y por tal motivo la Comisión Nacional del Espacio Exterior ha ofrecido ya algunos cursos al respecto y en la actualidad tiene en desarrollo un curso para entrenar técnicos mexicanos en este tipo de metodologías. Indicó que si bien en el pasado ha habido problemas de coordinación, muchos de ellos pueden ser explicados y que lo que es más importante es tener en mente que debe haber una coordinación efectiva, ya que existe el convenio firmado entre la Comisión Nacional del Espacio Exterior y la NASA al respecto y que sería sumamente deseable que cualquier otro convenio similar pudiera caer dentro de este convenio general.

El Ing. Higuera Mota ofreció toda clase de facilidades para que este nuevo proyecto relacionado con el estudio de la vegetación de Veracruz pudiera tener las facilidades que existen disponibles dentro de la Comisión que él dirige.

7° .- El Dr. Martín del Campo sugirió que debería hacerse una

distinción entre proyectos y programas específicos de investigación en los aspectos exclusivamente de servicios, ya que en el caso de la Comisión Nacional del Espacio Exterior las facilidades fundamentales que ofrece es de servicio en relación a obtener informaciones, datos, fotografías, vuelos, entrenamiento en técnicas, más no necesariamente en los aspectos relacionados directamente con programas específicos de investigación, los cuales deben mantener su individualidad.

8°.- El Ing. Héctor Alonso, representante de la CETENAL, indicó que ha venido siguiendo con mucho interés el desarrollo de las investigaciones que realiza la NASA a través de sus satélites para hacer investigaciones sobre recursos naturales de la tierra y que se interesan en colaborar o participar en proyectos de este tipo. Manifestó que le gustaría saber cuál es el proyecto específico de NASA para Veracruz, con el objeto de ver su posible participación.

9°.- El Dr. Gómez-Pompa dijo que la posición del grupo de investigación que él dirige, respecto a NASA, es que el proyecto de investigación sobre el mapa de vegetación de Veracruz debe ser un proyecto netamente mexicano. Este proyecto será dado a conocer a NASA para explorar su participación y colaboración, sabiendo que de hecho ellos están interesados. Sin embargo, recalcó que éste debe ser un punto que guíe nuestro trabajo hacia el futuro, porque las prioridades de investigación cooperativa internacional se deben dar en función de los intereses y proyectos me-

xicanos y no al contrario. Por tanto, en las próximas semanas se elaborará un proyecto detallado, una vez que se conozcan las posibilidades de participación mexicana de otras entidades, organizaciones, instituciones o personas para llevar a cabo este estudio. En función de ello este proyecto será presentado a NASA. Indicó además que la posible colaboración con NASA debe ser en función de obtener algún beneficio de esta participación y el beneficio puede ser obtener la información, métodos y técnicas nuevas en este campo.

10°.- El representante de la CETENAL, indicó que CETENAL estaría sumamente interesada en participar en este proyecto, aún cuando Veracruz probablemente será fotografiado hasta el año entrante, sin embargo, indicó que en cualquier parte del proyecto ellos estarían interesados en participar activamente.

11°.- El Ing. Higuera Mota de la Comisión Nacional del Espacio Exterior manifestó que esto podría ser una buena idea y que en la siguiente reunión Intersecretarial este proyecto podría ser presentado ante diferentes Secretarías de Estado para ver quienes se interesan en relación a este proyecto y ver si podemos obtener mayor colaboración o interés de otras dependencias gubernamentales para este proyecto.

12°.- El Dr. Gómez-Pompa mencionó que de hecho existen intereses perfectamente definidos por varias Secretarías de Estado y Comisiones, tal es el caso de la Comisión Federal de Electricidad en el Proyec-

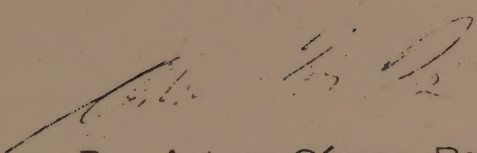
to de Laguna Verde en Veracruz, la Secretaría de Recursos Hidráulicos en el norte de Veracruz y en el sur de Veracruz, así como en la Comisión del Papaloapan en toda el área cubierta por la Cuenca del Río Papaloapan, que involucra gran parte del Estado de Veracruz.

13° .- Hubo varias intervenciones relacionadas a puntos aclaratorios del proyecto que se podría llevar a cabo y la importancia de coordinar esfuerzos en este campo. Hubo una sugerencia de poder tener reuniones semanales para ir analizando los diferentes proyectos y estado de avance en investigaciones relacionadas con los programas de colaboración, con la NASA. Hubo diversas opiniones en favor y en contra y se quedó de que la siguiente reunión se haría en función de la presentación del proyecto del mapa de vegetación de Veracruz y en esa ocasión se darían las fechas para discutir algunos problemas específicos de investigación.

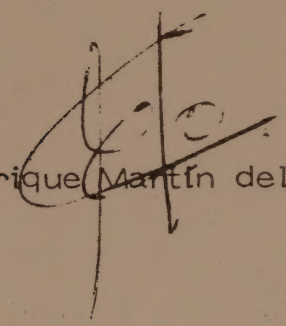
14° .- Se acordó tener una reunión en el CONACYT para hacer una evaluación de los trabajos que se vienen realizando en México en relación al gusano barrenador dentro del Programa Nacional de Ecología Tropical. Este Programa podría tomar a su cargo la coordinación de este tipo de reuniones, con el objeto de poner en contacto a los diferentes grupos involucrados en el tema. Se sugirió la posibilidad de tener una reunión lo antes posible, exclusivamente para ver los aspectos de investigación relacionados con el gusano barrenador y la participación de las instituciones mexicanas en dicho Programa.

15° .- Se quedó que la siguiente reunión sería citada con anticipación y la persona por parte del CONACYT que sería el punto de enlace, será el Dr. Jorge A. Vargas, de la Dirección de Asuntos Internacionales del CONACYT. Habiendo aprobado estos puntos se levantó la sesión.

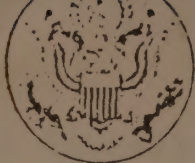
México, D. F., a 18 de Octubre de 1974.



Dr. Arturo Gómez-Pompa



Dr. Enrique Martín del Campo



DEPARTMENT OF STATE

Washington, D.C. 20520

Acta de Decisiones y Recomendaciones de la
Reunion de la Comision Mixta de Cooperacion Cientifica y Tecnica
entre Mexico y los Estados Unidos de America
Washington, D. C. 4 a 6 de junio de 1974

El presente documento es un sumario de decisiones, recomendaciones y otras acciones emanadas de la Reunion de la Comision Mixta de Cooperacion Cientifica y Tecnica entre Mexico y los Estados Unidos de America, que se llevo a cabo en Washington, D.C. los dias 4 al 6 de junio de 1974.

La Comision Mixta recibio y aprobo el informe conjunto presentado por el Consejo Nacional de Ciencia y Tecnologia de Mexico (CONACYT) y la Fundacion Nacional para la Ciencia de los Estados Unidos de America (N.S.F.) sobre las actividades llevadas a cabo a partir de la firma del Acuerdo de Cooperacion Cientifica y Tecnica. Tambien se recibio y aprobo el informe conjunto del CONACYT y el Departamento de Estado sobre el Programa Especial de Intercambio de Jovenes Tecnicos.

La Comision Mixta tomo nota de los Acuerdos vigentes que involucran actividades en Ciencia y Tecnologia, tanto aquellos a nivel Gubernamental como aquellos entre Organismos Federales de ambos paises y consideraron que estos Acuerdos ejemplifican el espiritu de cooperacion contemplado por el Acuerdo de 1972.

La Comision Mixta tomo nota de los esfuerzos realizados por el CONACYT y la NSF para identificar e inventariar las actividades de cooperacion cientifica y tecnologica en curso entre instituciones publicas, privadas e individuos de Mexico y los Estados Unidos de America. Expreso su aprobacion por la decision del CONACYT y la NSF para crear un comite conjunto que continue este esfuerzo. Adicionalmente, se reconocio que a pesar de que esta es una labor dificil y que el resultado final no sera necesariamente exhaustivo, la vision integral que provera tal inventario permitira a ambos Gobiernos considerar que proyectos y actividades adicionales pueden ser emprendidos.

En relacion con el alcance del Acuerdo, la Comision Mixta:

- 1) realzo el hecho de que el proposito del Acuerdo es el de fortalecer el desarrollo economico y social de ambos paises;
- 2) tomo nota de que, en reconocimiento del diferente nivel de recursos disponibles a ambos Gobiernos, es natural esperar que

la inversion estadounidense en el programa de actividades seria significativamente mayor que la inversion de Mexico y de que el programa reflejaria las areas prioritarias para el Gobierno Mexicano que son de interes comun y beneficio mutuos para ambos paises;

3) tomo nota de la anuencia de la NSF para facilitar el incremento en la comunicacion y el contacto entre el CONACYT y otros organismos e instituciones estadounidenses activas en los campos cientificos y tecnologicos, reconociendo que podria ser deseable para organismos de ambos paises el establecer contactos nuevos y directos con organismos del otro pais;

4) tomo nota de la preocupacion de la Delegacion Mexicana por el hecho de que instituciones y cientificos estadounidenses actuando fuera del marco del Acuerdo, en ocasiones no informan al Gobierno Mexicano o a las instituciones o los cientificos mexicanos interesados, acerca de proyectos de investigacion que llevan a cabo en Mexico. La Delegacion Mexicana expreso la necesidad de involucrar a las instituciones y cientificos mexicanos en la planeacion, implementacion, evaluacion y dissemination de los resultados de aquellos proyectos que se considere que lo ameritan y acepto proporcionar a la delegacion estadounidense, informacion especifica sobre algunos de estos casos, de modo tal que ambos Gobiernos puedan determinar las medidas que pudieran ser tomadas para remediar este problema;

5) acogio el anuncio de la Delegacion Mexicana de que el Gobierno de Mexico otorgara visas oficiales a los cientificos y tecnicos de los Estados Unidos que se internen en Mexico con objeto de desarrollar actividades dentro de los programas emanados del Acuerdo. La Delegacion Mexicana asimismo anuncio que con base en la nueva Ley General de Poblacion y de conformidad con las disposiciones legales existentes el Gobierno de Mexico otorgara una visa especial a los cientificos que, fuera del alcance del Acuerdo, vayan a realizar investigaciones dentro del territorio mexicano. La Delegacion de los Estados Unidos examinara la posibilidad de ~~diseminar informacion sobre estas nuevas medidas del Gobierno Mexicano~~ entre la comunidad cientifica estadounidense;

6) acogio el anuncio de la Delegacion Mexicana de que el Gobierno de Mexico ha establecido un comite interministerial especial para hacer expedita la resolucion de solicitudes de importacion permanente o temporal de equipo cuyo destino sea el apoyar los proyectos de naturaleza cientifica y tecnologica que lo ameriten

7) tomo nota de la intencion del CONACYT de incrementar los recursos financieros asignados al apoyo de los programas de cooperacion. La Comision Mixta expreso la confianza de que tal accion estimularia la presentacion de propuestas para proyectos adicionales por la comunidad cientifica de ambos paises, incrementandose asi el nivel de actividad dentro del Acuerdo, y

8) acuerdo que se designaria un comite ejecutivo de la Comision Mixta, integrado por dos miembros de cada Parte, para que realice una reunion a principios del ano de 1975, a fin de considerar asuntos de interes mutuo y recomendar a ambos Gobiernos una fecha adecuada para la segunda Reunion de la Comision Mixta, que tendra lugar en la ciudad de Mexico.

En la deliberacion sobre las areas de cooperacion la Comision Mixta tomo nota de las 6 areas especificas acordadas entre el CONACYT y la NSF, como aquellas que son del interes mutuo de ambos organismos y tambien tomo nota de las 4 areas adicionales en las que las prioridades mexicanas coincidieron con el interes de otros organismos estadounidenses para cooperar en proyectos conjuntos. Las 6 areas de interes comun son:

- Investigacion sobre Energeticos
- Investigacion Meteorologica
- Ecologia Tropical
- Recursos Minerales
- Recursos Marinos e
- Investigacion Demografica

Las 4 areas adicionales son:

- Agricultura Tropical
- Informacion y Documentacion, y
- Energia Geotermica

La Comision Mixta tomo nota del Acuerdo entre el CONACYT y la NSF para reunirse a fines de 1974, con objeto de considerar y aprobar los proyectos adicionales que se habran de llevar a cabo dentro del programa.

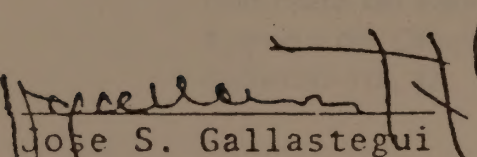
La Comision Mixta tomo nota del Acuerdo entre los Organismos Ejecutores (el CONACYT y el Departamento de Estado) responsables del Programa Especial de Intercambio de Jovenes Tecnicos para llevar adelante conversaciones en Washington encaminadas a examinar la conveniencia de revisar el Plan de Operaciones para la mejor realizacion de los objetivos del programa, en el entendimiento de que mientras esto sucede el intercambio de tecnicos continuaria conforme al actual Plan de Operaciones.

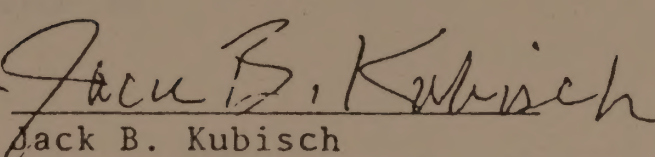
La Comision Mixta considero que la actividad de cooperacion en ciencia y tecnologia es un ejemplo de las relaciones profundas y amistosas que existen entre los dos paises y observo con asentimiento y satisfaccion el espiritu de buena fe y el deseo de conciliacion de puntos de vista que caracterizo a esta Reunion de la Comision Mixta de Cooperacion Cientifica y Tecnica Mexicano-Estadounidense.

Washington, D.C. a 6 de junio de 1974

El Presidente de la
Delegacion de Mexico

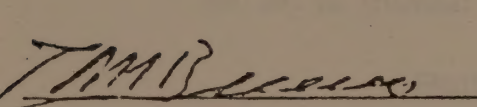
El Presidente de la
Delegacion de los Estados Unidos de America

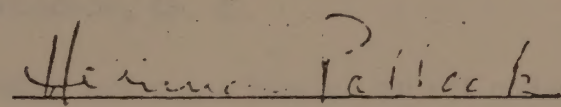

Jose S. Gallastegui
Subsecretario de
Relaciones Exteriores

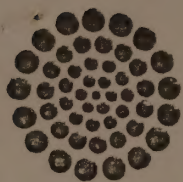

Jack B. Kubisch
Secretario de Estado Adjunto
para Asuntos Interamericanos

El Co-Presidente de la
Delegacion de Mexico

El Co-Presidente de la
Delegacion de los Estados Unidos de America


Gerardo Bueno
Director General del
Consejo Nacional de Ciencia
y Tecnologia


Herman Pollack
Director de
Asuntos Internacionales Cientificos y
Tecnologicos



CONSEJO NACIONAL DE CIENCIA Y TECNOLOGIA

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INSURGENTES SUR N° 1677 MEXICO 20, D. F.

DAI-74/1624

Octubre 18 de 1974.

DR. GONZALO HALFFTER
Museo de Historia Nacional
Cerrada de Monte Kamearún 34
Lomas de Chapultepec
México 10, D. F.

En relación con la junta convocada el día de hoy por el Dr. Arturo Gómez Pompa, Vocal Ejecutivo del Programa Nacional de Ecología Tropical de este Consejo, para tratar cuestiones relativas a la formulación y coordinación de un Programa Nacional de Investigación Científica sobre el tema mencionado, con la eventual participación de la NASA, con el presente me complace remitir a usted una copia del Acta Final de la Comisión Mixta de Cooperación Científica y Técnica entre México y los EUA, celebrada del 4 al 6 de junio del año en curso en la ciudad de Washington, D. C.

Reitero a usted las seguridades de mi más atenta y distinguida consideración.

DIRECTOR DE ASUNTOS
INTERNACIONALES

Dr. Enrique Martín del Campo

001-741624

Octubre 15 de 1974

UNIVERSIDAD NACIONAL AUTÓNOMA DE MEXICO
INSTITUTO DE INVESTIGACIONES EN CIENCIAS Y TECNOLOGIA
CARRERA DE INGENIERIA EN ELECTRICIDAD
CARRERA DE INGENIERIA EN ELECTRONICA
CARRERA DE INGENIERIA EN MECANICA

En relación con la junta convocada al día de hoy por el Dr. Manuel Gómez Farfán, Vocal Ejecutivo del Programa Nacional de Estudios Tecnológicos de las Ciencias, para tratar cuestiones relativas a la formación y capacitación de los Programas Nacionales de Investigación Científica y Tecnológica, con la eventual participación de los miembros de la Comisión de Estudios de la Investigación Científica y Tecnológica, con el propósito de presentar un informe a la Junta del Consejo Nacional de Ciencia y Tecnología, se ha acordado que el Dr. Gómez Farfán, en unión del Dr. Manuel Gómez Farfán, presenten un informe a la Junta del Consejo Nacional de Ciencia y Tecnología, en la ciudad de Washington, D. C.

Quedan a cargo las responsabilidades de este informe y documento correspondiente.

DIRECTOR DE ASUNTOS
INTECNAVAL 23

Dr. Enrique García del Campo

Cveg
W. 9/9/65

ABSTRACT

A PROPOSAL FOR A FEASIBILITY TEST
OF THE
USE OF REMOTE SENSING IN SCREWORM ERADICATION

This document contains a National Aeronautics and Space Administration (NASA) proposal concerning the use of remote sensing technology to support the U. S. Department of Agriculture (USDA) in its program of eradication of the screwworm fly. The current USDA program is directed at preventing reinfestation of the United States, which was cleared of overwintering populations of the fly in 1966. A future planned program includes fly eradication in a large part of northern Mexico.

As a prelude to the program, the NASA proposes to examine in concert with USDA, the feasibility of using remote sensing in the eradication effort. ⁽¹⁾ Studies would be limited to a defined test site within Mexico. ⁽²⁾ Remote sensing would provide detailed environmental data of the test site. ⁽³⁾ Simultaneous ground studies would relate insect ecology to collected sensor data. ⁽⁴⁾ An analysis would determine the usefulness of remote sensors for detection of environmental factors conducive to the growth of insect populations. ⁽⁵⁾ If test site studies are successful, such information could lead to a cost effective climatology system required for the major screwworm eradication effort. ⁽⁶⁾ The basic science developed could lead to useful application in eradication of other insect pests which have similar morphological characteristics as the screwworm fly.

2
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1000

A PROPOSAL FOR A FEASIBILITY TEST
OF THE
USE OF REMOTE SENSING IN SCREWORM ERADICATION

1. General

a. The screwworm fly has infested the tropical and temperate zones of North and South America and caused serious losses to livestock and wild animal life for over 125 years. The infested area extended from South Central Argentina and Chile as far north as Nebraska. The insect causes losses to warm blood animals by laying eggs in any open wound, no matter how small. The eggs hatch into larvae which eat deeply into the wound. If not detected and treated, the infected animal may die in a few days. Even after treatment the animal may be stunted, make slow weight gains, and be more susceptible to infection. The end result is increased cost of production, reduced income to ranchers and dairymen. In Latin America an additional problem is the simple fact that the result is a loss of an irreplaceable protein resource which is vital to human health.

b. Detection and treatment remained the only remedy to the problem until the late 1930s when a theory concerning the use of sexually sterile flies was developed. It was based on the fact that the female fly breeds only once in the life cycle. It was therefore theorized that if sterile male flies could be produced and seeded in the infested area for several generations, the fly population would disappear.

c. The theory was of minor practical value until 1951 when Cobalt-60 radiation sources were developed which provided a practical method of irradiating the larvae to produce sterile flies.

2. The Eradication Program in the United States

a. The eradication program in the United States was developed and carried out by the U. S. Department of Agriculture. The first area to be attacked was the Southeastern United States. Sterile flies were produced and distributed in the area by aerial seeding carried out by light aircraft. The problem was eliminated in the Southeast by 1959.

b. A similar program was launched in the Southwest United States in 1962. Sterile flies were produced at a new production facility at Moore Field, Mission, Texas, which was capable of producing 150 million flies per week. By 1966 the screwworm fly was eliminated from the United States.

c. The total cost of the eradication project in the United States was approximately 25 million dollars. It is estimated that the savings to the cattle and dairy industries amount to 120 million dollars annually.

3. The United States Barrier Program (Figure 1)

The elimination of the fly from the United States required a system for insuring against reinfestation from Latin America. To accomplish this task the Department of Agriculture together with the Mexican Government has established a barrier along the United States/Mexico border

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF POLITICAL SCIENCE
POL 301: THE POLITICAL THEORY OF THE MODERN STATE

1. Introduction

The first part of the course will introduce the political theory of the modern state. We will begin with a discussion of the historical context of the modern state, and then move on to a discussion of the theoretical foundations of the modern state. The second part of the course will focus on the political theory of the modern state, and the third part will focus on the political theory of the modern state.

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extending into Mexico in some depth. In this barrier area sterile flies are continually seeded and ground checks made periodically by agents of a joint Mexican-American commission for the control of screwworms and by residents of the area to detect evidence of reinfestation. "Hot spots" are then heavily seeded to restrict the spread of the insect and to eliminate its source. This program is supported by the sterile fly production plant at Mission, Texas, and by aircraft assigned to the Department of Agriculture. The cost of the barrier is five million dollars annually and it must be maintained indefinitely unless Mexico is cleared.

4. The Mexico Eradication Program

a. A Mexico/United States survey to determine the feasibility of a screwworm eradication program throughout Mexico has been completed. A favorable report has resulted in a detailed program prepared by the United States Department of Agriculture. The project is proposed as an item in the Department's FY 1973 budget. It is estimated that the program will require four years, with the first year devoted to construction of a new production plant in Southern Mexico or equipping a facility aboard a ship. Seeding operations will then continue for two years, with the fourth year devoted to assessing results. The two year seeding period may be reduced considerably if techniques currently under study prove successful.

b. Once Mexico is declared free of the fly the current (United States/Mexico border) barrier will be suspended and a new barrier activated in Southern Mexico.

5. Use of Remote Sensing

a. General

During the past few years a program has been underway to develop earth survey techniques utilizing remote sensing from aircraft and from spacecraft. Resources which have been surveyed in this manner include definition of geologically important areas, coastal and estuarine areas, soils and soil moisture, crops, timber, land use, watersheds, sea state, transportation networks, etc.

b. What is Remote Sensing?

Remote sensing may be thought of as the gathering of information without actual contact with the object or area being investigated. The earth observations instrumentation which gather such information take advantage of the physical principle that all materials radiate or reflect electromagnetic energy and the radiant spectrum is unique for each material making it identifiable. Spectral regions which have received primary attention for earth resources work include the ultraviolet, visible, infrared, and microwave. Advanced photographic techniques are emphasized in the visible range; radiometers, spectrometers, and multispectral

scanners in the ultraviolet, infrared; passive radiometers, scatterometers and side-looking imaging radars in the microwave region. Data accumulated from these sources indeed give the scientific investigator "new eyes" in observing man's environment. While these new methods are in their infancy when used in applications to earth's problems, they are proving cost beneficial in several instances.

c. Remote Sensing in Public Health Application to Insects

During recent months considerable effort has gone into a new program of the use of remote sensing to define environmental conditions which contribute to the degradation of human and animal health. A major subject of study has been that of insects and arthropods important to man's well being. This has included one small project to study the ecology of the screwworm fly as a model for all pupating insects. From this preliminary survey it is believed that remote sensing can contribute materially toward understanding environmental conditions where this insect thrives. However, it is also evident that insufficient scientific information is available concerning the total environmental requirements for this particular insect. While some data is available in the literature such as optimum soil temperature desired by the pupal stage, a comprehensive ecological model must be further developed. For this reason it is believed that remote sensing and appropriate ground studies in a small test area is mandatory prior to initiating aircraft operations in support of a major eradication effort.

6. Climatology and the Screwworm Fly

a. Background

The USDA proposal to eradicate the screwworm fly from Northern Mexico is an ambitious project. However, in the southern and southwestern United States, it has been shown that by utilizing aerial drop technique vast areas can be covered quickly and liberated from this insect pest. In these eradication campaigns considerable gain was acquired by taking advantage of weather and climatological conditions which limited and defined more precisely the affected zone. In the first Florida campaign an unusually severe winter killed numerous insects and suggested that the program be initiated some months previous to planned sterile insect releases. In Mexico, weather conditions should be more stable. Instead of temperatures increasing in the spring latitudinally from south to north as in the southern United States, it is affected primarily by changes in altitude. the terrain varies from the tropical lowlands to a central plateau and extends to numerous high mountain peaks. Several major canyons and river valleys complicate the climatology as their waters flow from the central highlands to the coast.

Another factor which influences the insect life cycle concerns the predominance of rainy and dry seasons in much of Mexico. The eradication campaign planners will undoubtedly take advantage of these seasonal ground moisture conditions which may preclude the development of insect pupae.

When working in the United States, planners received data from numerous weather stations available from the Weather Service. In addition, there were reports of soil moisture and other factors relating to crop production routinely reported to USDA. Within Mexico, the number of weather stations is materially reduced and climatological data reported from other sources is minimal.

From the above discussion it is reasonable to assume that additional detailed climatological data throughout Mexico is not only desirable but necessary to improve the cost effectiveness of the eradication program. Since it appears unlikely that sufficient detailed field reports will be available for planning purposes it will be necessary to either increase the number of observation points or to use some other method of gaining such information. Remote sensing technology might logically provide this data in a convenient format for operational use.

7. NASA Proposal

a. Test Site

It is proposed that NASA technology concerning the use of remote sensing be utilized to determine local climatology in a test site within Mexico. The test site would be selected for its varied altitude and environmental conditions which are conducive to the growth and study of the screwworm fly. It will be situated south of the current screwworm barrier drop zone to preclude the effects of sterile fly release on the naturally occurring population.

The USDA (Mexico City Office) has proposed a test site somewhere along Highway 86 between Ciudad Valles, Tps., and Rio Verde, S.L.P. (Figure 2). Final selection can be accomplished in the near future.

It is proposed that NASA aircraft overfly the test site prior to initiating detailed ground studies on the test insect. Additional overflights and collection of remotely sensed data would be undertaken at appropriate intervals as determined by the project manager and based primarily on data returned from the entomological and/or climatological ground truth team. Final analysis of test site results will determine the feasibility of its use in the major screwworm eradication campaign.

It is proposed that the test site also be the subject of ad hoc investigation by means of the Earth Resources Technology Satellite (ERTS). Staff members of the Health Applications Office, NASA, MSC, will be responsible for review of ERTS coverage of Mexico as it becomes available. It is anticipated that ERTS data will provide a fair amount of climatological information useful in the overall evaluation. Since the screwworm fly is a vigorous insect ranging over several miles in the course of his lifetime it is possible that ERTS material may be of sufficient resolution that aircraft data will not be required or its use may be materially curtailed.

b. Remote Sensing Instrumentation

The basic question to be answered if remote sensors are to be used is what are the highly reliable parameters that can be observed which relate to the environment of the screwworm. From previous experience, the factors that strongly influence the screwworm fly population are soil moisture, temperature, and vegetative cover. These items may be influenced by latitude and, in Mexico, variations may be affected primarily by altitude.

The basic types of aircraft remote sensing instruments to be used for measuring and recording the soil moisture, temperature, and vegetative cover are summarized in Figure 3 and spacecraft instrumentation in Figure 4.

c. General Working Arrangements

(1) A U.S. inter-agency working group (Figure 5) will be continued to complete technical details of the proposed joint effort to determine the feasibility of the use of remote sensing to assist in eradication of the screwworm fly.

(2) A general plan for organization is proposed in Figures 6 and 7.

(3) The Office of International Affairs, Headquarters NASA will coordinate with the Department of Agriculture and State to lay the necessary ground work for a cooperative international program between Mexico and the U.S. as described previously. They will attempt to expand current arrangements of the joint Mexican-American Commission for the Control of Foot and Mouth Disease and the Screwworm Fly (Figure 7) to include provisions for remote sensing as an adjunct effort. Due to the technical expertise in the U.S. Earth Observations Program it is expedient to assume that U.S. aircraft, spacecraft, and data processing facilities will be utilized in the test program. In this case it is highly desirable that appropriately trained Mexican nationals be invited to participate in total technical management of the remote sensing program. This might include entomology experts from the research staff of the Secretaria de Agricultura as well as remote sensing staff from the Exterior Space Commission. The Mexican Defense Ministry would necessarily become involved in the case of aircraft overflight. Working space for a small contingent can be arranged at the Manned Spacecraft Center.

(4) Upon completion of general agreements between the two countries there will be formed a Mexican-American Coordination Group (Figure 6) to promote harmony in the day to day operations of the program, to favorable publicize the results of goals achieved in the joint effort, and to contribute toward further programs between the two nations as appropriate.

(5) The day to day operational management of the remote sensing portion of the test site program is conceived primarily as a function of the Health Applications Office, (Health Services Division, Life Sciences Directorate, Manned Spacecraft Center, NASA) located in Houston, Texas.

This office is colocated within the Earth Observations Division, (Science and Applications Directorate) at the same center. From this position, health related functional programs are conducted and supported by the entire staff including aircraft and data processing facilities. Appropriate staff members of the U.S. and Mexican governments should be invited to participate in routine management of field operations and analysis as members of the Remote Sensing Operations Team. In this way the necessary interface can be maintained between cognizant agencies. If resident, on site participation cannot be arranged, regular meetings must be held to coordinate the various aspects of the program.

(6) NASA proposes to furnish jointly with the Mexican space agency through contractor support arrangement, some technical and scientific staff to complement the research effort within the test site (Figure 6). Specifically it proposes to provide the expertise required to accumulate "ground truth" information necessary to understand data gathered by aircraft or spacecraft. Operation of the test site would be the responsibility of the joint Mexican-American Campaign for Control of the Screwworm Fly which is now in existence as a sub effort of the Mexican American Commission for the Control of Foot and Mouth Disease. Further details on organization, personnel, and support will be resolved in meetings of the interagency task force and by agreement with the joint Commission.

d. Costs

(1) It is proposed that the costs of the feasibility tests be the joint responsibility of the affected agencies of both governments. Operation of the ground test site could be adjudicated the same way as that currently being conducted by the joint Campaign for the Control of the Screwworm Fly. NASA (MSC) has already budgeted for some technical assistance to ground truth support for the test site.

(2) It is proposed that if U.S. aircraft and/or spacecraft are used, costs supporting the feasibility test operations be borne by NASA as well as data reduction and processing costs.

(3) The Mexican government should be asked to provide staff support and travel funds for those members assigned to work at the Houston project office. NASA can supply necessary work space and office supplies to support routine work requirements.

(4) Unanticipated costs are expected to be shared on a 50 - 50 basis or approved by participating agencies of the governments concerned.

(5) USDA is encouraged to detail sufficient technical staff to NASA (MSC) Houston to support routine operations of the Remote Sensing Operations Team and the test site within Mexico. Office space and routine support can be arranged within the Health Applications Office.

THE CURRENT U.S./MEXICAN BORDER BARRIER



FIGURE 1



FIGURE 3.

AIRCRAFT INSTRUMENTATION OF VALUE IN SCREWORM RESEARCH

REMOTE SENSOR SYSTEM

MEASUREMENT/DISCIPLINE

PHOTOGRAPHIC

COLOR PHOTOGRAPHY
COLOR IR PHOTOGRAPHY

BLACK AND WHITE STEREO PHOTOGRAPHY
MULTI-SPECTRAL PHOTOGRAPHY

BASE MAPPING
VEGETATION
• SOIL MOISTURE
• SOIL TYPE (POROSITY)
TOPOGRAPHY (FINE)
VEGETATION

INFRARED

IR THERMAL SCANNER

PRECISION RADIATION THERMOMETER

TEMPERATURE GRADIENTS
• SOIL MOISTURE
• SOIL TYPE (POROSITY)
TEMPERATURE

MICROWAVE

RADAR
RADAR ALTIMETER
PASSIVE MICROWAVE

TOPOGRAPHY (ROUGH)
ALTITUDE
SOIL MOISTURE

MUCH INFORMATION IS INFERRED FROM THE DIRECT MEASUREMENT. FOR EXAMPLE, KNOWING THE TYPE VEGETATION PRESENT, THE SOIL TYPE IS KNOWN FROM THE REQUIREMENTS TO SUPPORT SUCH PLANTS, THE SOIL MOISTURE IS PARTIALLY INFERRED BY ASSESSING PLANT HEALTH OR STRESS.

FIGURE 4.

ERTS INSTRUMENTATION OF VALUE IN SCREWORM ENVIRONMENT RESEARCH

RETURN BEAM VIDICON (RBV)

No. 1	.475	.575
No. 2	.580	.680
No. 3	.690	.830

MULTISPECTRAL SCANNER (MSS)

CHANNEL 1	.5	.6	
CHANNEL 2	.6	.7	
CHANNEL 3	.7	.8	
CHANNEL 4	.8	1.1	
CHANNEL 5	10.4	12.6	(ERTS B ONLY)

(INSTANTANEOUS FIELD OF VIEW 260 FT. X 260 FT.)

FIGURE 5.

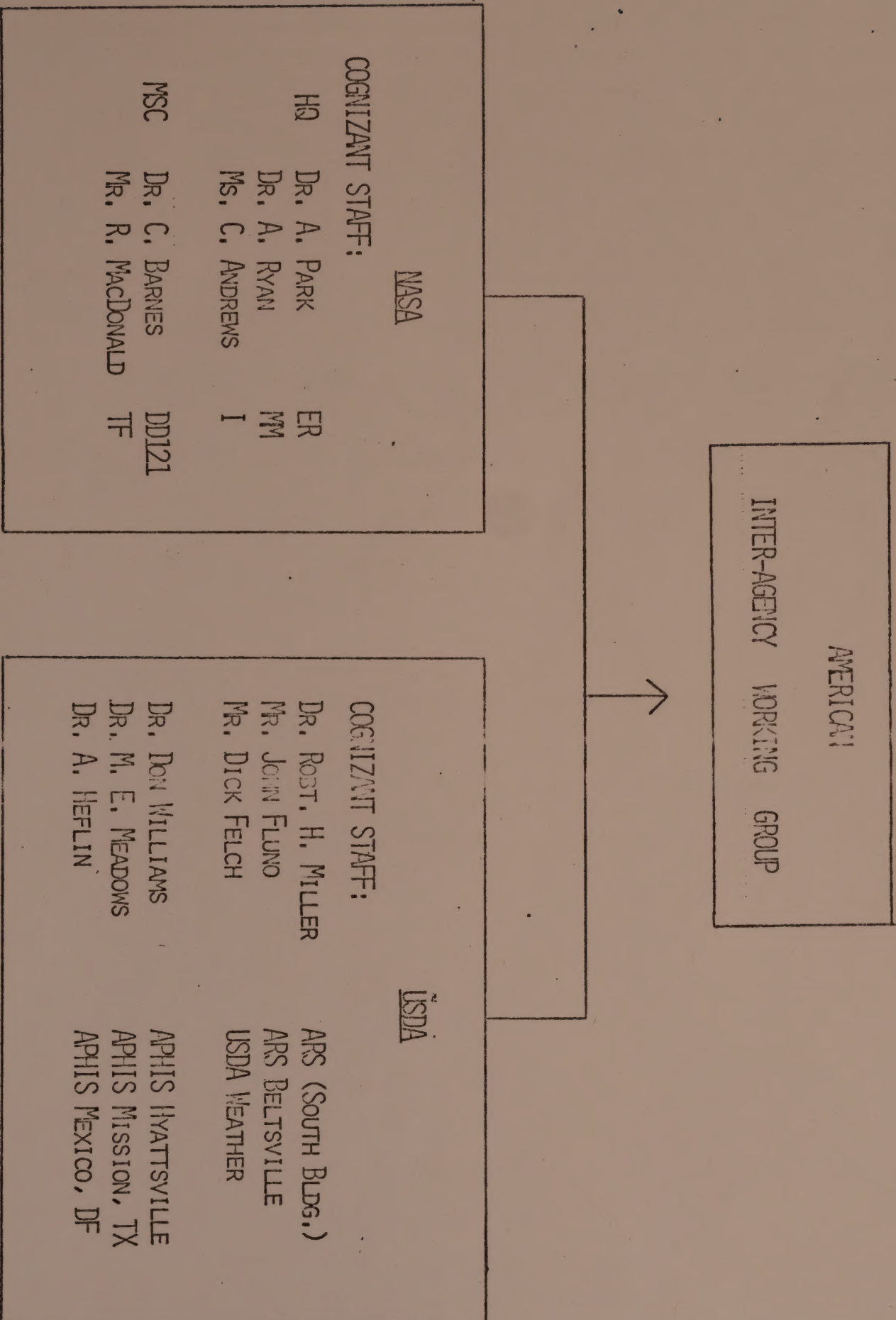


FIGURE 6.

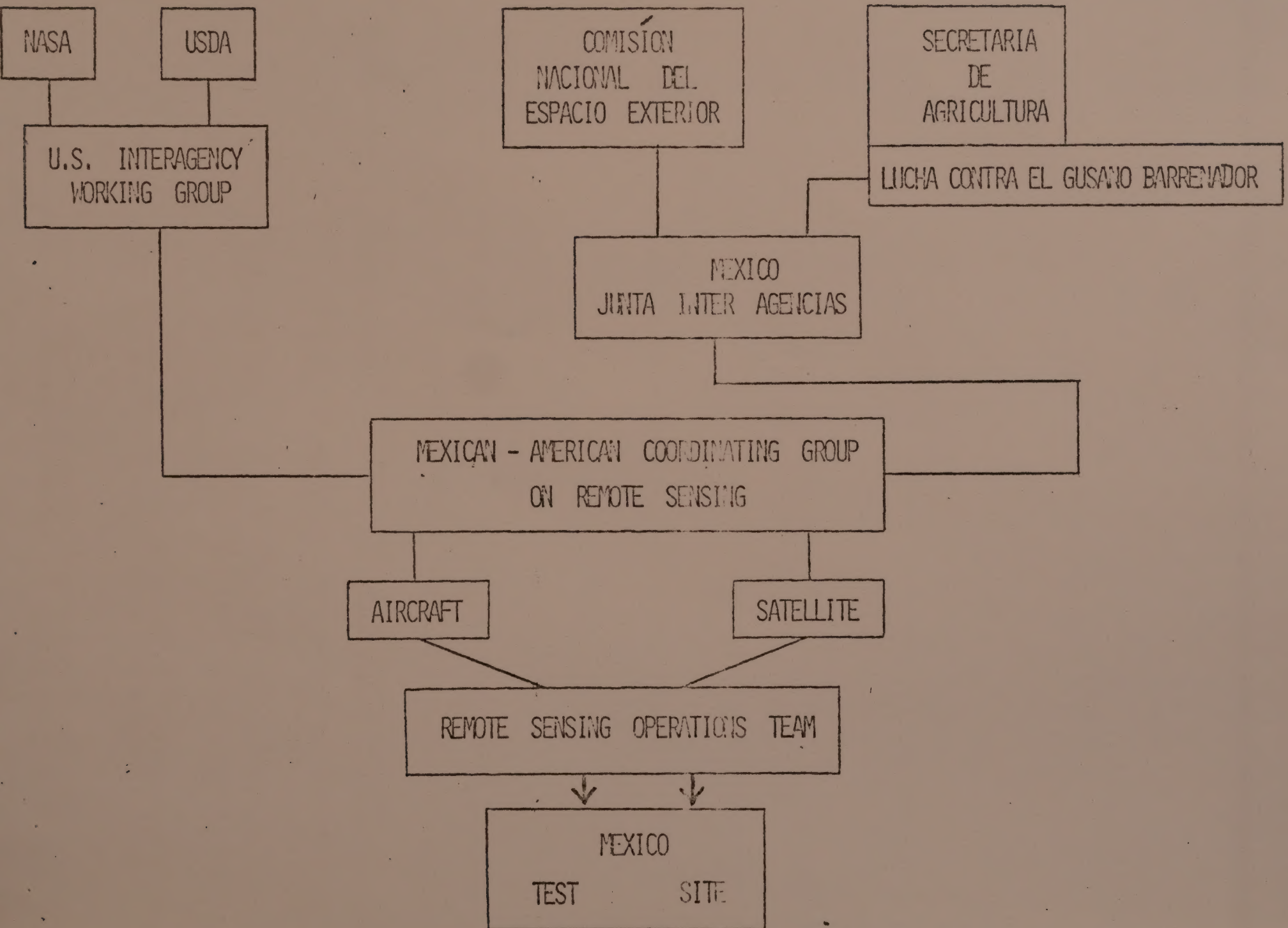
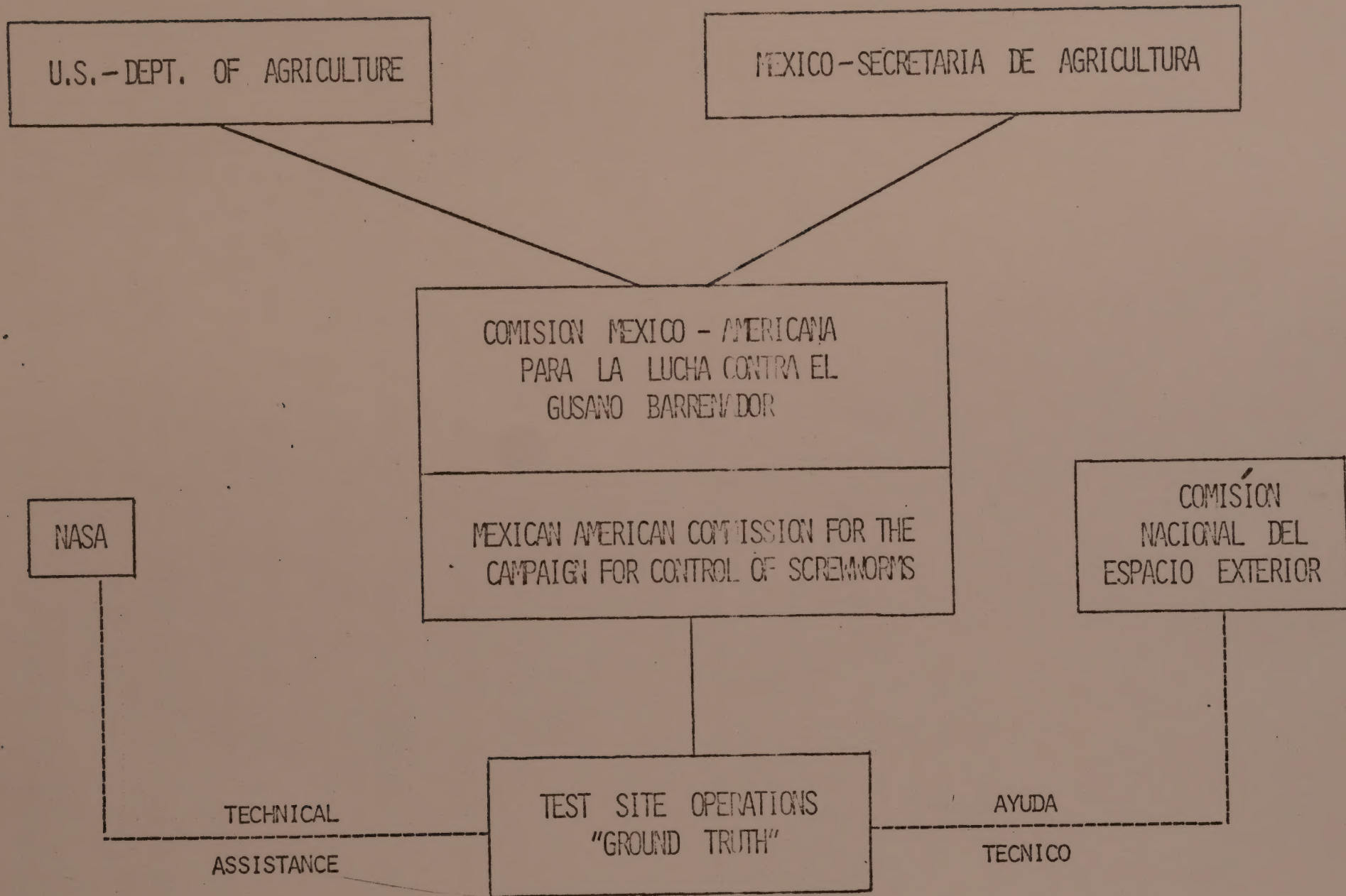


FIGURE 7.



It is proposed that NASA and USDA establish in concert with the Mexican government a screw worm research test program at a site previously selected near Linares, Tamaulipas, Mexico. The division of responsibility and effort should be as follows:

SPACE COMMISSION (U.S. and Mexico)

1. Coordinate the entire remote sensing effort.
2. Supply the sensors applications experts.
3. Arrange for over-flights of the test site by remote sensing aircraft.
4. Provide analysis of remote sensing data collected from these over-flights.

DEPTS. OF AGRICULTURE (U.S. and Mexico)

1. Coordinate the entomological research program on the ground.
2. Provide professional entomologists and assistants as required.
3. Provide ground transportation, traps, thermometers, hygrometers, and other equipment required to determine environmental conditions at the test site.

JOINTLY

The agencies will jointly do a final analysis of remote sensing and ground collected data to determine the usefulness of remote sensing in improving methods of screw worm eradication.

IMMEDIATE PROBLEM

Because the experimental test site is located within Mexico, it is necessary to develop a protocol agreeable to both nations. Current NASA policy may preclude over-flights of U. S. remote sensing aircraft in foreign countries. However, it would seem inadvisable to fund Mexican aircraft to accomplish the remote sensing mission since they lack sufficient sensors and analytical capability to quickly establish the validity of current insect eradication concepts. However, an agreement is in existence by Mexico and the U. S. for the joint eradication of this disease. Approximately 30 U. S. employees are engaged in this work within Mexico. It is proposed that the present agreement be extended to permit involvement of the Mexican Space Commission's (Comision Nacional del Espacio Exterior) remote sensing team as required. It is proposed that NASA invite a Mexican space official along with an entomologist from the Secretaria de Agricultura of Mexico to work with United States scientists in this program at NASA-Houston. In this way it

might be possible to develop an international team which would utilize a U. S. remote sensing aircraft for this project.

The approximate flying time from the U.S.D.A. experiment station, Weslaco, Texas, to the Mexican test site is 30 minutes and it is expected that no more than 3 or 4 over-flights per year would be required during the test program. Assuming success in the test schedule it might be feasible to utilize ERTS A satellite data for the actual eradication program which involves all of Mexico rather than the test site.

PRELIMINARY MEETING

Representatives of U. S. agencies affected by this proposal are invited to meet at the NASA Manned Spacecraft Center at 0900 on Monday, January 17, to discuss how this plan may be implemented. Meeting will be held in Room 860 , Building 2.

CMBarnes

C. M. Barnes, D.V.M., Ph.D.

DC71

Manned Spacecraft Center-NASA

Houston, Texas 77058

Tel. (713) 483-4251

July 24, 1970

SUBJECT: ERTS Experiment Proposals

TO: Dr. Robert H. Miller
Acting Assistant to the Administrator, OA
Agricultural Research Service
Washington, D. C. 20250

The enclosed brief research proposals are enclosed in response to your phone request of July 21. They are entitled:

"Screwworm outbreak incidence and the vegetation environment"

"Reflectance from vegetation, soil, and water"

"Use of space data in watershed hydrology"

"Wind erosion susceptibility of Southern High Plains of Texas Soils"

You will notice that we did not include a proposal for the experiment entitled "Evapotranspiration on the Great Plains." We feel that experiment should be the responsibility of the Great Plains Agricultural Research Council.

The proposal dealing with screwworm control should be discussed with the appropriate people. Dr. Vozzo of the Public Health Ecology Project at NASA-MSC Houston has prepared a Form 1122 for a "theoretical model for determining the presence of this insect using remote sensing techniques;" Dr. Warren Ross (202) 388-8625 or Dr. Williams ~~will~~ visit here and at the Mission ~~Insect~~ Eradication Laboratory on August 11. This project struck ^{me} as a very practical one; we do not need or care to be ^{involved} involved.

I trust these are of the nature you need.

Craig L. Wiegand
Craig L. Wiegand
Director

cc:

J. R. Johnston

D. W. Fryrear

L. Vozzo

B. J. Blanchard

J. van Schilfgaarde

S. C. Gartman

W. A. Allen

File

M. A. Hartman

W. Ross

N. P. Woodruff

g 10720

Investigation Title: Screwworm outbreak incidence and the vegetation environment.

Location: Screwworm Division
Animal Health Division
Hyattsville, Md. 20782
(202) 388-8625

National Aeronautics and Space
Administration
Manned Spacecraft Center
Houston, Tex. 77058
(713) 483-4251
(713) 483-7372

USDA, ARS
Animal Disease Eradication
Mission, Tex. 78572
(512) 585-1646

Principal Investigators:

Dr. Warren Ross, Screwworm Division, ARS
Dr. C. M. Barnes, Public Health Ecology Project, Code TF711
Dr. W. T. Gartman, Animal Disease Eradication, Mission

Objectives:

1. Study the relation between screwworm outbreaks and vegetation indicators of rainfall distribution and vegetation growth conditions.
2. Devise and test an operational plan to direct heavy releases of sterile male flies to geographical areas where conditions for hatches indicate screwworm outbreaks will occur.

Need for Study:

Screwworm infestations are known to be associated with flushes of growth of native vegetation ("greening stage") and antecedent rainfall. The ERTS return beam vidicons will relay data in about the same spectral bands and with the same resolution as the Apollo SO-65 experiment photography, i.e. a resolution of 200-300 feet on the ground. The following table, taken from p. 23 of the NASA SP-230 "Ecological Surveys from Space", shows clearly that shrub type, vegetation density, and vegetation vigor should be identifiable on ERTS imagery. Thus the experiment prepared is feasible.

TABLE.--Expected detection feasibility of earth features in ERTS imagery, RBV and MSS*.

Type of Earth resource feature	Photographic film-filter combination				
	Black-and-white photos		Color photos		
	Pan-58 (green)	Pan-25A (red)	Infrared- 89B (infrared)	Ektachrome (normal color)	Infrared Ektachrome (false color)
Vegetation Resources:					
Natural or cultivated vegetation	+	+	+	+	++
Trees, shrubs, or herbaceous vegetation	+	+	+	+	++
Hardwoods or conifers	-	-	-	-	+
Individual tree species	-	-	-	-	--
Chaparral, desert shrub, or other shrub type	-	-	-	+	+
Vegetation density	-	+	+	+	++
Vegetation vigor	-	-	+	-	+

++ = Signifies that the resource feature is consistently identifiable by most photointerpreters on space photographs flown to the specifications indicated; only rarely is a mistake made.

+ = Signifies that the resource feature is usually identifiable on the space photographs; however, to avoid numerous mistakes, care must be taken that the photointerpretation is done by personnel having a strong background of training and experience in the resource discipline involved (e.g., forestry, agriculture, range management).

- = Signifies that the resource feature is usually unidentifiable on space photography flown to the specifications indicated; however, with moderate improvement either in image quality or photointerpretation skill, most "-" ratings could be converted to "+".

-- = Signifies that, important though the resource feature may be, it is consistently unidentifiable on space photography flown to the specifications indicated.

* indicates RBV (ERTS multi-spectral TV return beam vidicon system) and MSS (ERTS multi-spectral scanner system).

The U. S. Department of Agriculture and the government of Mexico are launching a \$25 million effort to eradicate screwworms from Mexico. The ERTS imagery (both ERTS A and B) can be obtained from the entire Southwestern U. S. and as much of Mexico as is of interest. Detailed ground studies over such an area are almost prohibitively expensive. If information from field reporters or sensor platforms were combined with ERTS interpreted imagery it should be possible to create an economical workable system to anticipate screwworm outbreaks. Distribution of the sterile males in the areas of expected large hatches should reduce the total number required by deploying them more efficiently. The result could be a more effective program at lower cost.

Procedures to be Followed:

Existing space photography of the areas of interest will be obtained *and studied along with available vegetation maps and information available from the present eradication effort.* The ERTS data will be scrutinized as soon as they start becoming available to learn whether they and a network of "field reporters" suffice to characterize conditions conducive to outbreaks. The observations in the field reports would be made on the day plus or minus one, of the satellite overflight and on 18 day intervals.

If early in the ERTS experiment the field reports and ERTS data are shown to indicate that outbreaks can be anticipated, this experience will be developed into an operational system for improving the distribution of the male sterile flies.

Utility of Results:

Screwworms are a problem of considerable economic consequence. They are widely distributed geographically and in areas inaccessible to ground observation. However, there is a vigorous eradication effort in progress. If ERTS data could be used to increase the efficiency of the eradication effort, it would save taxpayers a bundle.

Funds Required:

(The existing organization for eradication of screwworms will supervise this effort. The challenge is not so much in organizing but in coordinating the effort so that the ERTS data are rapidly processed, studied, and the information disseminated to the eradication center).

Personnel:

Professionals (3) --One at NASA Goddard, one in Hyattsville, and one at Mission, Tex. -----	\$ 50,000.
Technicians (2) -----	20,000.
Clerical -----	15,000.

Equipment:

Light tables (2) -----	4,000.
Facilities for rapid examination of imagery ----- (Spatial Data Systems Datacolor or other system; facilities possibly available at NASA Goddard, NASA Houston)	60,000.
Photography (for permanent record of color displays, if desired) and processing -----	15,000.
Film library equipment -----	5,000.

Operating Costs:

Building services (Utilities, janitorial, etc.) -----	8,000.
Communications -----	10,000.
Travel -----	8,000.

T O T A L ----- \$ 195,000.

JUL 27 1972

Mr. Charles W. Mathews
Associate Administrator for Applications
National Aeronautics and Space Administration
Washington, D. C. 20515

Dear Chuck:

Attached is a proposal for a feasibility test of the use of remote sensing in screwworm eradication. This test would be conducted in Mexico as a joint effort between NASA and the Department of Agriculture on the United States side and in consort with the Secretaria de Agricultura and the Comision Nacional del Espacio Exterior of the Mexican Government. If successful, the test could lead to definitive arrangements to assist the joint Mexican-American campaign for the control of the screwworm fly in its program to eradicate this pest from all of Mexico.

We have discussed the feasibility of this test with officials of the Animal and Plant Health Services, U. S. Department of Agriculture and believe that NASA can contribute to the presently planned program. If you concur with the proposal it is requested that the Office of International Affairs be asked to initiate the preliminary interagency and international arrangements for conducting the test.

Sincerely,

Original Signed By

CHRISTOPHER C. KRAFT, JR.

Christopher C. Kraft, Jr.
Director

Enclosure

cc:
NASA Hqs., Dr. Charles A. Berry, MM

DD12/CMBarnes:rs:5/11/72:5406

AB- 7-25
OFFICIAL FILE COPY

CONCURRENCES

OFFICE CODE	TEV	TA	RS	HA	CE	GS
	McDonald	Calic	Armstrong	Johnston	Charlesworth	Sabbey
INITIALS						
DATE			5-12-72		5-11-72	

October 25-30, 1971

SUMMARY

A trip was made to Mexico to investigate areas suitable for a test site for studies concerning effects of environment on the incidence of screwworms. It is hoped that through NASA's remote sensing techniques the environment for screwworms can be mapped and this information relayed to control authorities. I was accompanied by U.S. and Mexican government officials. A test site approximately 100 miles south of Monterrey, N.L. was selected.

Principal Contacts

Dr. Allen Heflin, Thomas C. Fisher, U. S. Dept. of Agriculture. Dr. Marco A. Villasenor - Secretaria de Agricultura - Mexico, Dr. Alfonso Garza N., Director de Facultad de Medicina, Veterinaria y Zootecnia, Centro Educativo, Adolfo Lopez Mateos, Ciudad Victoria, Tamps., Mexico. Ing. Sergio Padilla G. - Comision Nacional del Espacio Exterior was contacted by telephone but could not attend due to shortage of travel funds.

Discussion

In accord with previous discussions with U.S. officials it was planned to investigate two potential sites; one near Aramberi, N.L. and the other north of Torreon in the state of Durango. (See Trip Report of July 7, 1971.) Upon arrival in Monterrey, discussions were held with Mr. Fisher and his Mexican counterpart relative to this plan. It was decided that due to lack of precise information in Durango, the extremely mountainous terrain, and the flying distance from the United States it would be much more convenient to seek a site nearer headquarters of the screwworm campaign at Monterrey. A trip was made to Aramberi N.L. It was found that roads between that site and the Gulf Coastal plain were non-existent and that it would be necessary to ride horseback if that site were selected.

Enroute to Aramberi we had examined a site beginning at Linares N.L. on Mexico National Highway 85 extending west along Highway 60 and 31 to its junction with National Highway 57 near San Roberto. Topographically the area varies from a low coastal plain of 400 meters at Linares to a high mountainous plain of 2000 meters near San Roberto. In addition, there is a highway extending to a telecommunications relay station on Mount Potosi at 3700 meters altitude. These features should contribute to extensive climatological differences satisfactory for our environmental studies. Of major significance is the fact that the length of the proposed test site is covered by a good highway with some intermittent side roads and trails extending into the site from the highway. This would permit convenient placing of fly traps and specimen collections at routine intervals.

Trip Report - October 25-30, 1971

During the trip a brief stop was made at the University in Ciudad Victoria. A fiesta was in progress so minimal contact was had with the staff. However, one staff member agreed that the University would probably be glad to establish a research project in cooperation with the Mexican-American screwworm program.

Recommendation

In accord with the above and in consideration of discussions held with American and Mexican officials it is recommended that a remote sensing test site be established for study of the screwworm environment in Mexico. Ground truth studies of this area should begin as soon as possible and overflights be planned in accord with preliminary reports from ground observers.

CM Barnes

C. M. Barnes

DC71/CMBarnes:lmr:12/10/71:4251

disease incidence along with environmental factors is being plotted.

In summary there appears to be a definite correlation between humidity and temperature conditions and the spread of the screwworm fly.

At the Cotaxtla Agricultural Experiment Station located near Paso del Toro, Veracruz, an effort is being made to determine the incidence of the screwworm insect in the lowlands of Veracruz State. Flies are marked in the pupal stage by means of paint and their capture is recorded at traps located various distances from the release point. Flies from various parts of Mexico are being compared under field conditions to study genetic influences. Tests are also being made of the effectiveness of various insecticides. A tremendous quantity of detailed information is available at this site but was not available for me to carry away since there were no extra copies nor was there a machine available for making such copies. Perhaps of greatest interest to our proposed program was the fact that the numbers of flies in the northern Veracruz region increase tremendously during the months of January through June which is the dry season and drop to levels of less than 50% of the maximum during the balance of the year which is the rainy season. In climates which lack the rainy-dry season variability, populations appear static. This might indicate that it would be more productive to attempt an eradication program during the rainy season when the population is at its lowest. In the view of the Cotaxtla experimenters there are significant differences between both humidity and temperature extremes which could be profitably utilized in planning an eradication effort. It is significant that the Cotaxtla station is not currently conducting research in the mountainous regions of Veracruz where extremes in temperature could be studied.

Both the U.S. and Mexican staff agree that an experimental test site including variable temperature and humidity should be secured and a program of study concerning these effects on insects in the field should be accomplished, particularly as relates to remote sensing. One area near Ciudad Victoria in the State of Tamaulipas was suggested as a prime area for consideration. It has been a continual hot spot of screwworm infestation even though it is less than 100 miles south of the Texas border and has been seeded with sterile flies on a continuing basis. The proposed terrain consists of low-land tropical jungle and a dry, yet low altitude plain separated by a mountain range. The mountain range apparently blocks moisture coming in from the Gulf Coast providing a wide fluctuation in temperature and humidity conditions within a relatively small area. This site appears favorable from the point of view that it is near the U.S. Border including the Weslaco, Texas Experiment Station of the USDA which is being over-flown at routine intervals for various agricultural remote sensing purposes. Secondly, it might be feasible to install remote sensors on the Mission, Texas aircraft which fly over

this area at routine intervals to drop sterile flies.

A second area proposed is near Torreon in the State of ^{Durango} Coahuila. This area is located in the central part of northern Mexico which has never been adequately covered with sterile flies. Again, there is a low-land valley surrounded by large mountains and a river which undoubtedly contributes to the continuing population of flies in the area. There are extremes of temperature, altitude, and humidity which might be sensed remotely to assist in determining growth and distribution of the screwworm fly. A consideration favoring this test site is that it is reasonably close to the Texas border, about 350 miles south of Big Bend National Park. Another distinct advantage is that the fly populations have not been significantly influenced by sterile fly releases or the use of large quantities of insecticides. A disadvantage might be that the terrain is inordinately mountainous causing some danger to low level flying which may be required for environmental sensing. It is suggested that a committee of Mexican-American screwworm officials plus Mexican-American remote sensing officials visit both sites if it appears feasible that one or more of the sites should be used in the trial program. Preliminary investigation for these sites is currently being accomplished by the Mexico-American Commission (Drs. Tarver and Villaseñor). Other sites may appear more favorable as a result of their investigation.

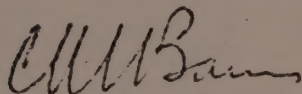
A visit was made with Sr. Ing. Ramon Solis, Department of Photo Interpretation, Secretariat of the President, in Mexico City. Ing. Solis had previously worked with U.S. space officials on Mission 91, the joint Mexican-American effort to determine efficiency of remote sensing for various country development projects. Ing. Solis has prepared and published numerous new maps of Mexico resulting from their remote sensing and photographic work throughout the Republic. It is evident that these maps will mean much to scientific personnel working toward the development of the Mexico industrial and agricultural complex. It is interesting to note that neither Ing. Solis nor any of the Mexican officials had thought of remote sensing as a tool for public health. Dr. Villanueva (Cotaxtla) was not aware that Mission 91 had been flown nor that data covering experimental areas for which he is responsible was available from the Mexican government. He suggested that at Cotaxtla they were doing much grasslands research including several botanical diseases and insect pests (spittle bug) in the Popalopan Valley. He planned to make inquiry for assistance in studying the broad geographic problem associated with the disease studies in progress.

Ings. Higuera and Padilla from the Mexican Space Commission were at first worried that a NASA-Houston person was visiting in Mexico talking about remote sensing without their leadership. It was ex-

plained that the problem was being adequately staffed by the Mexican-U.S. Departments of Agriculture and that the use of remote sensors was an innovation which hopefully could be utilized to assist with an agricultural-public health problem. Further, the current conferences, were the first discussions between our two agencies on this subjects, were preliminary in nature, and would be fully staffed through international channels before any firm action is taken. It was delightful to note the enthusiasm of these two engineers for such a program and it is believed that we will have complete cooperation by the Mexican Space Commission in any joint effort. Leadership for such a program within Mexico should perhaps be joined between the Space Commission and the Mexican Department of Agriculture since both would be involved in planning the research effort.

On Friday, June 25, personnel of the Mexican Space Commission invited other members of their remote sensing committee including Sr. Ing. Valdes of the National Council of Science and Technology for Mexico; and Sr. Ing. Castaneda, the Director General for Geography and Meteorology for the Mexican Department of Agriculture and Sr. Ing. Castillo of the Mexican Institute of Petroleum to listen to a 30-minute presentation on remote sensing as applied to public health. The response was most interesting and the committee agreed it was a "must" that a public health official be invited to join their national committee on remote sensing to permit utilization of this new science for the betterment of Mexican health.

Sr. Ing. Higuera and Dr. Villasenor are expected to visit Houston and the Mission, Texas screwworm plant in the not too distant future to discuss informally the steps for beginning the joint research program. Dr. Barnes will continue coordination activities for DC71 and prepare the ground work for program approval.



Charles M. Barnes

cc:

DC71/Dr. Fuller
 USDA-ARS/Dr. Williams
 USDA-Mexico/Dr. Heflin
 SRR/Dr. Park
 SRR/Dr. Jacobs
 USDA/Dr. Miller
 USDA-Mission/Dr. Hightower
 PAHO/Mr. Hanson
 TF/Mr. Holter

For Comments to Snow

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
NATIONAL PROGRAM STAFF
Beltsville, Maryland 20705

✓ EAT _____
✓ WFS *2/7/8*
— JE *8*
— NC _____

March 5, 1975

Subject: MRRL Program of Research on Cochliomyia hominivorax

To: Milt Ouye, PACS

Transmitted herewith is my only copy of the subject report which was developed by Gerald Holt at my request. This report shows that an 8-man multidisciplinary team of ARS and SAES scientists has been assembled at Fargo. The end objectives of this effort are to:

- (1) provide various kinds of attractants (oviposition, sex, etc.) for detection, assessment, and possibly suppression of screwworm populations, and
- (2) provide a radar system for tracking the movement of individual screwworms in nature.

I recommend that if additional funds are made available for screwworm research, a reasonable percentage of such funds be allocated to MRRL. I am confident that this team will come through for us. Also, I feel that this involvement in an internationally significant problem will tend to assure the role of MRRL as a "National laboratory."

Please return the subject document when you no longer need it.

Waldemar Klassen

Waldemar Klassen
Staff Scientist
Pest Management

Enclosure

cc:
L. S. Henderson
H C Cox
E. A. Taylor ✓
C. H. Schmidt

*go Snow for comments
3/10/75- JG*

RECEIVED

MAR 10 1975

AREA OFFICE
WESLACO, TEXAS

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
INTERNATIONAL PROGRAMS DIVISION
HYATTSVILLE, MARYLAND 20782

March 7, 1975

Subject: Lectures--IAEA Training Course on "Use of
Radioisotopes and Radiation in Entomology,"
University of Florida, July 7-August 20, 1975

To: A. W. Cooper ✓
E. R. Glover
H. R. Thomas

3/11/75

	Cooper	
1	Cooper	3/11/75
	Reine	
	Swanson	
	Mercley	
	Burges	
	Lucy	
2	Burges	F

Pls inform AD

There is enclosed a letter from the United States Energy
Research and Development Administration in response to my
letter to them of February 12, 1975, of which you received
a copy. This means that the travel and per diem costs
will be arranged for the following individuals: LaChance,
Lingren, Davich, Cross, Flint, Tilton, and White. It is
our understanding that the Southern Region would bear the
cost of the participation of Mr. Snow.

Kenneth A. Haines

Kenneth A. Haines
Director

Enclosure

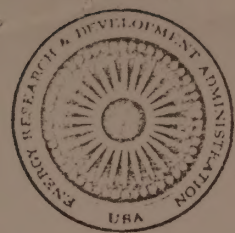
cc:
W. G. Eden

*when you submit ex. acc. suggest
you contact S. R. for number?*

EOT

Copy sent to J. W. Snow

May 22, 1975



UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

MAR 5 1975

Mr. Kenneth A. Haines, Director
United States Department of Agriculture
Agricultural Research Service
International Programs Division
Hyattsville, Maryland 20782

Dear Ken:

We have reviewed your letter of February 12, 1975 concerning financial assistance for the travel and per diem of ARS lecturers for the IAEA training course on "Use of Radioisotopes and Radiation in Entomology," which is to be conducted at the University of Florida, July 7 to August 20, 1975. We are glad that you will be able to make the eight lecturers available whom Dr. Eden, University of Florida, requested and that you can finance the travel and per diem of one of them, Mr. Snow. We are prepared to finance the travel and per diem of the other seven lecturers.

Dr. Eden is pleased with this arrangement and has assured us that the University will be agreeable to handling the travel and per diem payments under the agreement which we will negotiate with the University of Florida for conducting the course.

Sincerely,

A. S. Friedman, Director
Division of International Programs



3/7
4-2

File out

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
NATIONAL PROGRAM STAFF
Beltsville, Maryland 20705

April 1, 1975

Subject: NASA Screwworm Model

To: R. J. McCracken, Associate Administrator

Through: H. O. Graumann, Assistant Administrator *H.O.G.*

Dr. Don Williams, APHIS Program Development and Application Staff, and I have had some recent discussions on the above subject. I have also talked to Dr. Wendell Snow. There is background information I should relay to you and I will conclude with some recommendations.

As a sidelight, Dr. Williams tells me the Mexico-U.S. Screwworm Commission meeting scheduled for April 21 in Guadalajara, Mexico, has been postponed until May, with the exact date yet to be set.

Dr. Barnes of NASA has led a considerable effort in that agency toward developing a screwworm model. We understand there have been contracts with Philco and Lockheed as part of that work. ARS made available to NASA all the biological and ecological information we could provide, including what was in quarterly reports from the early days of screwworm research. I do not know how much, if any, of that information may be of a preliminary nature that would need further research for verification. NASA has used data on ground temperatures and soil moisture obtained by remote sensing from satellite passes over Mexico. Dr. Williams has urged Dr. Barnes to get ARS involved in the program but with little success. Our people have participated in some meetings and discussions, but apparently not in any technical details of the actual development of the model.

NASA, or a contractor, or both, have used a base in Mexico for ground truth observations. It extends from sea level to about an 8,000-ft. elevation. They operated within the area some 20 to 25 weather stations and about 40 liver-bait screwworm traps. It is understood their biological data were disappointing because of the small numbers of flies captured. They did have a good entomologist at the site. We understand there were ground truth observations also made in south Texas. In that flat area the temperature and moisture data were about $\pm 2\%$ accurate. In the more rugged Mexican terrain it was only about $\pm 5\%$, according to indirect word I have received.

RECEIVED

APR 10 1975

AREA OFFICE
WESLACO, TEXAS

Dr. Williams believes that Dr. Barnes considers he has developed a workable model and is ready to turn it over to APHIS for use. Through FY 1976 he would send APHIS at frequent intervals a set of four 2x2 slides covering Mexico. They would show ground color, ground temperature, soil moisture, and areas where conditions are favorable for screwworms. Beginning in FY 1977 NASA would expect APHIS to take over funding for this function, and it might be rather expensive.

So far as I can determine, nobody in APHIS or ARS has seen or knows about any details of how the model was developed, or of the mathematics around which it was formulated. Dr. Wendell Snow knows only in general what NASA has been doing. He considers that they do not have a population model such as ARS entomologists have been developing. He believes it may be more of a weather model to indicate screwworm potential as a result of influence of soil temperature and moisture on the life cycle of the insect. Several other inputs would be required to predict population levels and research would be required to develop those inputs.

Neither Dr. Williams, Dr. Snow, nor I consider that APHIS should accept this NASA product as a firm guide for their operations until we know more about it. There should be observations over a period of time to determine its reliability, whether modifications may be required, or whether there should be further research inputs. It is our understanding that NASA has funding for further research on this project for FY 1976.

The following recommendations are made:

1. APHIS and ARS should attempt to obtain details about the base for the NASA model, and learn how it was constructed, preferably obtaining any reports that may be available.
2. ARS should collaborate with APHIS Methods Development at Mission to observe the workings of the model and assess its reliability. An APHIS Epidemiologist should also participate in this study. APHIS at Tuxtla Gutierrez would be involved.
3. ARS has capabilities in remote sensing and insect modeling that should be utilized in an evaluation or review of the model. Dr. Robert H. Miller, NPS Scientist for remote sensing, should be involved. The scientists at Weslaco, Texas, might also be helpful.
4. We should determine whether any modifications are required in the model, or whether further inputs may be required to make it workable.

5. As soon as we are able to arrive at an opinion, we should make a recommendation to APHIS as to whether or not the model appears to be a reliable guide for them to use in the screwworm eradication program in Mexico.

L. S. Henderson

L. S. Henderson
Staff Scientist

cc:

Dr. Cooper, SR

Dr. Snow, Mission, TX

Mr. Taylor, Subtropical Texas ✓

Dr. Williams, APHIS

Via telecopier 8/6/75 J.E.

*To: H C COX
From: E.A. TAYLOR*

DRAFT (Revised 8/5/75 E. A. Taylor: J. W. Snow)

Subject: Evaluation of Screwworm Eradication Data System

To: F. J. Mulhern, Administrator, APHIS

This is in further reference to our earlier correspondence regarding the above subject. Several members of our staffs met on July 31 in order to discuss research required to determine applicability of the NASA Screwworm Eradication Data System (SEDS) to screwworm eradication operations. Participants from APHIS were Drs. Donald Williams (Hyattsville) and Floyd Smith (Mexico City). ARS participants were Drs. Robert Miller (Washington), Wendell Snow (Mission) and H C Cox (New Orleans). It is my understanding that NASA believes its system to be currently operational, has indicated that funding for development will terminate at the end of FY76, and has proposed that APHIS take over the system after FY76.

NASA has been making weather data from the system available for the past few months. Our scientists have systematically reviewed the data from the system, and based on their 1975 screwworm data preliminary analysis, consider its application to screwworms in its present form as hazardous. Not only have they been unable to correlate screwworm occurrence with predictions from the system, but other factors make it appear that the system has not been completely perfected. These factors range from less important (for example, variations in the color codes of predictions of conditions conducive to screwworm growth) to extremely important (for example, no reports due to long periods of cloud cover in southern Mexico).

While our ARS scientists have evaluated the current system as unsatisfactory, we cannot evaluate the eventual prediction capability of SEDS until all pending modifications have been made. At that time, we believe we should evaluate the system over an entire year that is four full seasons. We realize that NASA has budgeted their work on SEDS only through this fiscal year. However, if the system is to be seriously considered for operational use, it would be unfair to NASA and SEDS to make an evaluation before they are completely satisfied that the system is operational. Therefore, we would hope that NASA would be encouraged to continue the project to completion. Specifically, enough time is needed to perfect the system and then allow us time to adequately evaluate it.

In the meantime, the Screwworm Research Laboratory will continue to make evaluations on the predictive capacity of SEDS by using data on known screwworm cases supplied by the APHIS program. While most of the data will probably be from south Texas, we will also consider such data from Mexico as is available from reports made to Hyattsville.

*Floyd Snow
to H C Cox
8/6/75
J.E.*

NASA has scheduled a technical review of SEDS and their proposed participation in the joint Mexican-American Program in Houston on August 10-20. Dr. James Novy (APHIS), Drs. Marco Villasenor and Norvan Meyer (Joint Commission), and Drs. Wendell Snow and Robert Miller (ARS) have been invited to attend.

The meeting will undoubtedly include discussion of NASA's Phase II Project Plan, Screwworm Eradication Data System (SEDS) Field Tests. The document proposes field tests in Mexico as a joint effort among NASA, USDA, the Secretaria de Agricultura, SAG, and the Comission Nacional del Espacio Exterior (CONEE). The proposal indicates that SEDS has been operational since mid-March 1975, producing data with sufficient accuracy to be useful in monitoring screwworm growth but that it must be field tested and evaluated before it is used operationally. We will, of course, be glad to work with NASA to the extent possible with current resources in order to assist them in modifying and improving their system over time.

While we have doubts about a simplistic system involving only temperature and moisture, we feel that the concept of a predictive system is good and could eventually be useful in an operational screwworm eradication program. However, such a system should include a number of other variables such as types of vegetation and stages of growth, wild life in the area, program effects, ranching operations such as shearing, lambing, dehorning and branding, and so forth. Hopefully, NASA will find the means to continue involvement with SEDS until a satisfactory system is developed, but in event they do not, we will be interested in learning the extent of your interest in our undertaking research to develop such a system. We would have to consider such a research program within the limits of our current resources; however, we would not want to redirect current research on attractants, biology, ecology, and nutrition.

DRAFT

(Revised 8/5/75 EAD: gws: jws)

Subject: Evaluation of Screwworm Eradication Data System

To: F. J. Mulhern, Administrator, APHIS

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While our ARS scientists have evaluated the current system as unsatisfactory, we cannot evaluate the eventual prediction capability of SEDS until all pending modifications have been made. At that time, we believe we should evaluate the system over an entire year that is four full seasons. We realize that NASA has budgeted their work on SEDS only through this fiscal year. However, if the system is to be seriously considered for operational use, it would be unfair to NASA and SEDS to make an evaluation before they are completely satisfied that the system is operational. Therefore, we would hope that NASA would be encouraged to continue the project to completion. Specifically, enough time is needed to perfect the system and then allow us time to adequately evaluate it.

In the meantime, ^{the screwworm research} our Mission laboratory will continue to make evaluations on the predictive capacity of SEDS by using data on known screwworm cases supplied by your Mission facility. While most of the data will probably be from south Texas, we will also consider such data from Mexico as is available from reports made to Hyattsville.

the APHIS Program.

NASA has scheduled a technical review of SEDS and their proposed participation in the joint Mexican-American Program in Houston on August 19-20. Dr. James Novy (APHIS), Drs. Marco Villasenor and Norvan Meyer (Joint Commission), and Drs. Wendell Snow and Robert Miller (ARS) have been invited to attend.

The meeting will undoubtedly include discussion of NASA's Phase II Project Plan, Screwworm Eradication Data System (SEDS) Field Tests. The document proposes field tests in Mexico as a joint effort among NASA, USDA, the Secretaria de Agricultura, SAG, and the Comision Nacional del Espacio Exterior (CONEE). The proposal indicates that SEDS has been operational since mid-March 1975, producing data with sufficient accuracy to be useful in monitoring screwworm growth but that it must be field tested and evaluated before it is used operationally. We will, of course, be glad to work with NASA to the extent possible with current resources in order to assist them in modifying and improving their system over time.

eventually
While we have doubts about a simplistic system involving only temperature and moisture, we feel that the concept of a predictive system is good and could be useful to an operation^{al} screwworm eradication program. However, such a system should include a number of other variables such as types of vegetation and stages of growth, wild life in the area, program effects, ranching operations such as shearing, lambing, dehorning and branding, and so forth. Hopefully, NASA will find the means to continue involvement with SEDS until a satisfactory system is developed, but in event they do not, we will be interested in learning the extent of your interest in our undertaking research to develop such a system. We would have to consider such a research program within the limits of our current resources; however, we would not want to redirect current research on attractants, biology and ecology, and nutrition and rearing, unless you feel such changes would be desirable.

F. J. Mulhern

2

In the meantime, our Mission laboratory will continue to make preliminary (Reviewers: is there a better word?) evaluations on the predictive capacity of SEDS by using data on known screwworm cases supplied by your Mission facility. While most of the data will probably be from south Texas, we will also consider such data from Mexico as is available from reports made to Hyattsville.

*obtain N
action program*

NASA has scheduled a technical review of SEDS and their proposed participation in the joint Mexican-American Program in Houston on August 19-20. Dr. James Novy (APHIS), Drs. Marco Villasenor and Norvan Meyer (Joint Commission), and Drs. Wendell Snow and Robert Miller (ARS) have been invited to attend.

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While we have doubts about a simplistic system involving only temperature and moisture, we feel that the concept of a predictive system is good and could be useful to an operational screwworm eradication program. However, such a system should include a number of other variables such as types of vegetation and stages of growth, wild life in the area, ranching operations such as shearing, lambing, dehorning and branding, and so forth. In the event that the evaluation of SEDS indicates that it is not adequate for operational use, we will be interested in learning the extent of your interest in our undertaking research to develop such a system. We would have to consider such a research program within the limits of our current resources; however, we would not want to redirect current research on attractants, biology and ecology, and nutrition and rearing unless you feel such changes would be desirable.

✓ EAT *EAT*
✓ WFS *WFS*
— JE *JE*
— NC

Screwworm Research Laboratory
P. O. Box 986 Moore Air Base
Mission, Texas 78572

September 23, 1975

Subject: Current Events - NASA

To: H C Cox

As requested, this memo is written to bring you up to date on "NASA affairs" since the meeting in Washington. As suggested 2 staff members and myself attended the August meeting in Houston. They were included because I felt research would probably be required and hearing the presentations would be beneficial. Our plans were to support APHIS to the level required.

The total NASA package, from satellite capability to population modeling, was presented with great skill. The stated NASA position was that the "product" was basically complete and only needed evaluation. They expressed the belief that additional data or modifications were unnecessary and for those reasons suggested Drs. Novy and Gartman (APHIS) along with Dr. Charles Barnes (NASA) serve as an evaluation committee. I firmly believe NASA attempted exclusion of ARS because of the earlier ARS suggestion that NASA personnel be used only for resource purposes in an evaluation. Drs. Sharman and Corrigan, the ranking APHIS officials in attendance, did not object to this arrangement. At the conclusion of this meeting it appeared ARS involvement had ended.

A meeting of this committee was called by NASA for Sept 16 and my attendance was suggested by Don Linquist (on Sept 12). A request had come from APHIS for our continued involvement. At the meeting NASA presented a preliminary document for discussion that included Drs. Novy, Gartman, Bickerton (APHIS-computer) and Barnes as committee members with Dr. Chaloux the single USDA contact. Dr. Gartman suggested my inclusion and this was accepted by NASA. A copy of the final document is attached. It outlines the steps and procedures to be followed in the evaluation. Dr. Peterson's involvement was requested as a support member to insure sound statistical procedures. About 25% of his time will be required until Feb. 1 to complete the evaluation. Please permit his involvement to this level.

As of this writing, NASA plans 3 modifications to the system before the real time evaluation. They are (1) an altitude correction (2) an emis-

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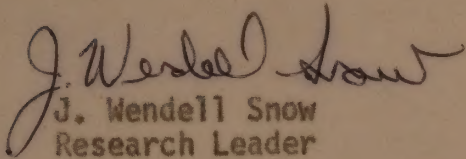
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2.

sivity correction (3) and the addition of ground meteorological data when cloud cover exists. However additional modifications can be made until the real time evaluation.

In conclusion, I recommend ARS support of this plan because we can get a good evaluation in a relatively short period of time. Drs. Gartman and Novy are Screwworm experts and can be expected to be fair and unbiased.

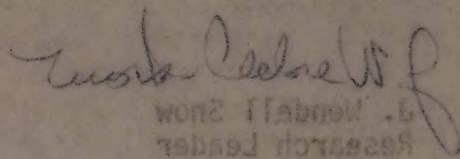

J. Wendell Snow
Research Leader

Enclosure: a/s

cc: E. A. Taylor, Weslaco, TX ✓
D. A. Lindquist, Beltsville, MD

5.
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In conclusion, I recommend ARS support of this plan because we can get a good evaluation in a relatively short period of time. Drs. Garman and Hoyt are screwworm experts and can be expected to be fair and unbiased.


J. Wendell Snow
Research Leader

Enclosures: 4/2

cc: E. A. Taylor, Weslaco, TX
D. A. Lindquist, Beltsville, MD

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION/
U.S. DEPARTMENT OF AGRICULTURE

SCREWORM ERADICATION DATA SYSTEM (SEDS)
FIELD TEST AND EVALUATION PLAN

SEPTEMBER 17, 1975

APPROVED BY:

Dr. P. A. Chaloux
Associate Deputy Administrator
USDA/APHIS

Dr. F. J. Mulhern
Administrator, APHIS
USDA

W. E. Rice
Assistant Manager, Earth Resources Program Office
NASA/JSC

J. R. Morrison
Manager, Earth Resources Survey Program
NASA Headquarters

1.0 SUMMARY

This document describes proposed field tests and evaluation of a remote sensing system which may assist in screwworm eradication. The test and evaluation activity will be conducted in the United States as a joint effort of the National Aeronautics and Space Administration (NASA) and the U.S. Department of Agriculture (USDA). Basic sponsorship of this evaluation effort in the USDA is the Animal and Plant Health Inspection Service (APHIS), with the ARS supporting, as requested. The Johnson Space Center (JSC) will be the NASA counterpart.

In general, the USDA will be responsible for determining the effectiveness of the satellite system in providing data of value to the screwworm eradication program. NASA will be responsible for reducing satellite data and supplying technical support during the evaluation.

To properly evaluate the potential role of the Screwworm Eradication Data System (SEDS) for screwworm eradication requires the following:

- a. A technical verification and evaluation of the basic principles of remote sensing to establish feasibility, success criteria, requirements for a system to be used in screwworm eradication, and to determine SEDS value as an information source for decision making.
- b. An operational assessment of the practicality and cost benefit of the SEDS in the eradication program.

The details of each of these areas are reflected in section 3.0.

2.0 BACKGROUND

A project, "Remote Sensing as an Aid to Screwworm Eradication," was established in 1974 and was to be accomplished in three phases: (1) preliminary development, (2) field test (verification), and (3) operational implementation.

The objective for the first year's development work was to verify the feasibility of correlating screwworm fly population changes with radiometric temperature and other weather data as observed by remote sensors aboard satellites operated by the U. S. National Oceanic and Atmospheric Administration (NOAA). Test sites were established in Texas and in Mexico, and ground climatological data that affect the population dynamics of the screwworm fly were collected. Satellite data covering large areas were successfully processed on a routine basis to establish correlation with ground-collected weather information.

Results from the Phase I effort indicated general reliability of the satellite to measure the near-ground environment with sufficient accuracy to be useful in monitoring screwworm growth provided that an initial population of flies existed in the area. Further, testing of the satellite system indicated that such information could be reliably collected about 50 percent of the time. The balance of the data would be less reliable because of cloud cover or poor satellite coverage.

At the same time that research and technical procedures were being studied in the test areas, a sophisticated data analysis system was being developed for operational use in the screwworm eradication program. This SEDS system has been quasi-operational since mid-March 1975, producing estimates of environmental parameters for geographic regions which are conducive to the growth of screwworms or where screwworms are unlikely to exist. At the present time, the products (consisting of color coded maps) from this system are being produced daily. Although the SEDS has completed the hardware development phase, the system must be field tested and evaluated to determine practical application. Some of the mathematical expressions and insect weather models that were entered into the system were preliminary and need evaluation and refinement. This can only be done by comparing SEDS products over an extended period of time with USDA case information (ground truth).

3.0 EVALUATION

The SEDS technical verification and evaluation will be conducted jointly by NASA and the USDA. The following is a breakout of each agency's major responsibilities.

The USDA will:

- a. Verify that the SEDS provides reliable predictive information related to screwworm habitat (USDA and NASA).
- b. Determine SEDS output product requirements.
- c. Evaluate the utility of output products in field operations.
- d. Provide for ground truth and historic and current insect case data to support the evaluation effort and for further model improvements.
- e. Conduct a cost-benefit analysis of the SEDS utilization.
- f. Define the steps leading to technology transfer, assuming favorable evaluation of the SEDS (USDA and NASA).
- g. Determine the value of other field information to the screwworm eradication effort and provide the necessary information for input into SEDS evaluation.

The NASA will:

- a. Verify that the SEDS provides reliable predictive information related to screwworm habitat (NASA and USDA).
- b. Develop and modify the initial SEDS to meet specific USDA requirements within current budget constraints.

4.0 SUPPORT

During the field evaluation phase of SEDS, it will be necessary to obtain field information on the number of screwworm cases to test validity of this system and to refine it further. Currently, screwworm data are obtained from the U.S. along the Mexican-U.S. border in the form of daily reported screwworm cases. These data will be correlated with SEDS predictions on screwworm growth. The evaluation team is particularly interested in zones which may show little or no correlation between SEDS predictions and actual screwworm cases. These inaccuracies may be due to any of the following reasons:

- a. Since SEDS has a limited ground data resolution, small areas may exist with high screwworm growth potential that are not resolved and shown in the prediction products; e.g., deep canyons in semi-arid and arid areas or extremely rugged terrain.

- b. Animal husbandry practices, host populations, accuracy of reports, and sterile fly release, are the major factors in screwworm epidemiology, and these will influence the correlation between data on actual screwworm cases and SEDS predictions.

- c. Areas with unusual weather may present problems of interpretation or data gathering, as in the case of cloud-blanketed zones.

The USDA will furnish basic data about screwworm incidence in the areas in question and such information as host density, animal husbandry practices, sterile fly release, or other unusual conditions, if required.

5.0 MANAGEMENT PLAN

5.1 Organization

The joint evaluation team will be comprised of the USDA and NASA personnel. Dr. Chaloux will be the USDA single point of contact for major policy and management decisions. Mr. Rice will be the NASA/JSC counterpart. The technical evaluation team will consist of Dr. Novy, Dr. Gartman, Mr. Bickerton, Dr. Snow, and Dr. Barnes. Other USDA and NASA personnel will support the evaluation as determined by this group. The technical team will define the detailed tasks in each area of the evaluation and assign personnel responsible to accomplish the tasks.

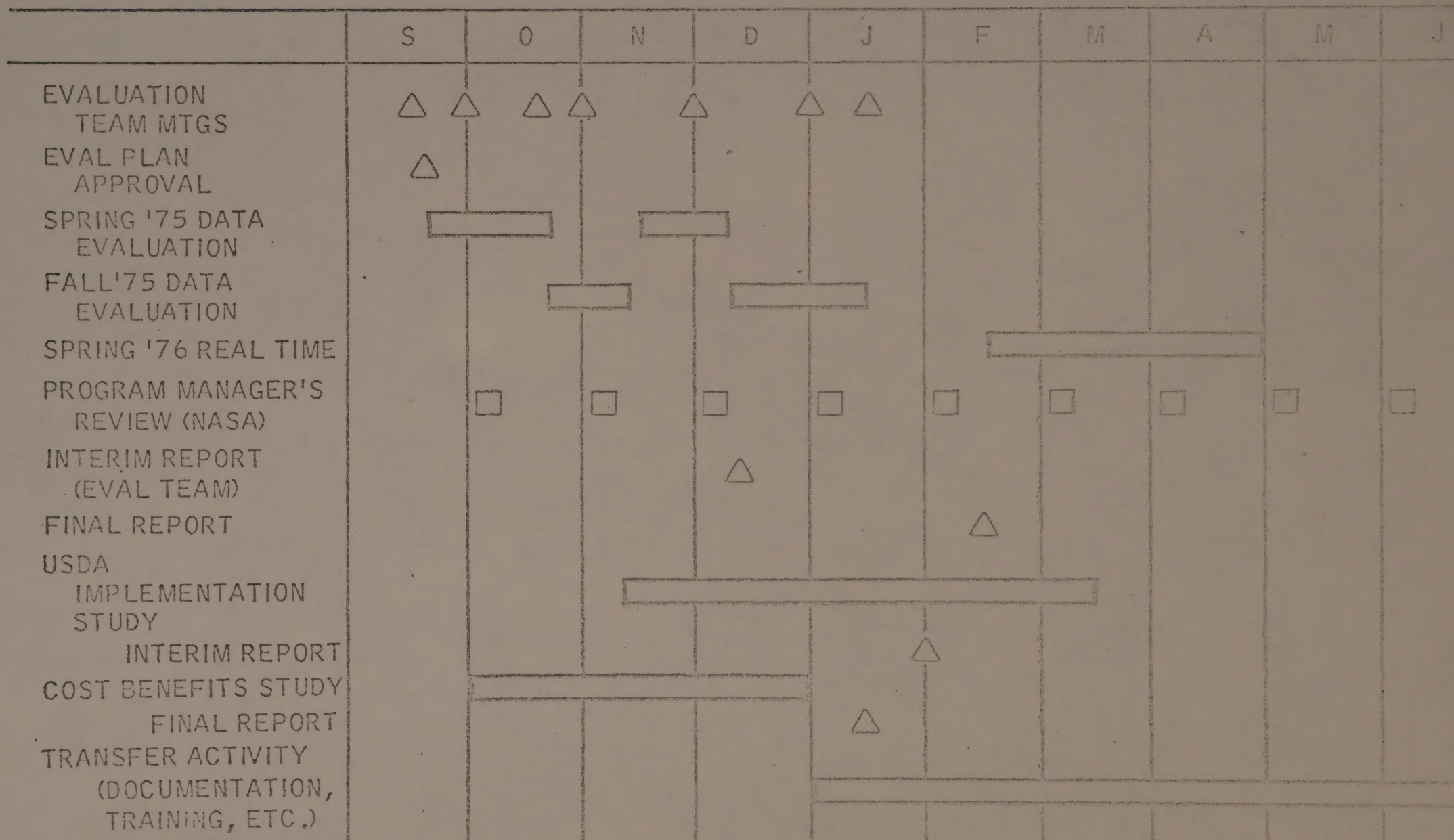
5.2 Scheduling

To assist the principal officials of the agencies concerned in the functions of planning, controlling, and reviewing project activities, a master schedule will be maintained which shows the major activities (see figure). This schedule will be reviewed by management on a monthly basis.

5.3 Funding

In carrying out this cooperative effort, the USDA and NASA will each fund their respective responsibilities. NASA anticipates termination of SEDS activities on July 1, 1976.

SEDS EVALUATION SCHEDULE





AGRICULTURAL
RESEARCH
SERVICE

701 LOYOLA AVENUE
P.O. BOX 53326
NEW ORLEANS, LOUISIANA 70153.

UNITED STATES
DEPARTMENT OF
AGRICULTURE

SOUTHERN REGION
OFFICE OF DEPUTY ADMINISTRATOR

September 29, 1975

Subject: Screwworm and NASA Remote Sensing
System

To: Ralph J. McCracken
Associate Administrator

This is in further reference to my August 6 letter to you regarding the above subject and to your August 12 letter to F. J. Mulhern regarding "Evaluation of Screwworm Eradication Data System". I am enclosing a copy of J. W. Snow's September 23 letter to me on the subject "Current Events - NASA". I believe his report will bring you up to date on ARS activities in this matter.

We plan to assist APHIS and NASA to the extent possible in conducting the evaluation. However, it now appears that APHIS has decided to take the lead in obtaining the information they need in order to make a decision regarding purchase of the system. Earlier, of course, they had asked that ARS evaluate the system and make recommendations to them.

We presume that Dr. Mulhern has not responded to your August 12 letter.

H C Cox

H C Cox
Associate Deputy Administrator

Enclosure

cc:

✓ E. A. Taylor
J. Wendell Snow
T. B. Kinney
C. W. Carlson

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OCT 1 1975

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WESLACO, TEXAS

APR 30 1976

Ed Taylor

Mr. William E. Rice, Assistant Manager
Earth Resources Program
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

Dear Mr. Rice:

Enclosed for your review and appropriate NASA distribution are five copies of the draft of the USDA evaluation of the Screwworm Eradication Data System (SEDS).

If you have any comments, relative to the content of this report which you would like considered prior to submission of the final USDA team report, please forward them in writing to Dr. Williams by May 14.

George E. Bickerton

for
USDA Members
Joint Evaluation Team

5 Enclosures

APHIS:MID:GEBickerton:kmr:4/30/76

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FILE: SECTION Research
SUBJECT Screwworm - Rodeo Snail
FOLDER NASA-ARS In. Carver

EVALUATION OF SEDS: A REPORT FROM THE
USDA MEMBERS OF THE JOINT EVALUATION TEAM

April 1976

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EVALUATION OF SEDS: A REPORT FROM THE USDA

MEMBERS OF THE JOINT EVALUATION TEAM

INTRODUCTION

SEDS

The Screwworm Eradication Data System (SEDS) was developed by the Health Applications Group at the Johnson Space Center of NASA for the purpose of assisting the Mexican-American Screwworm Commission in its screwworm eradication effort in Mexico. It is a sophisticated weather data system designed to produce information relative to the local environment in Mexico that is conducive to the growth of screwworm populations or areas where screwworms are not likely to exist.

The Screwworm Eradication Data System is comprised of eight individual measures which are derived from two basic components. The first basic component is temperature which is measured from either a satellite source or meteorological stations. The second component is moisture which is introduced as a crop moisture index. These two components are subsequently broken down into the following elements:

1. Short term mean air temperature.
2. Short term mean air temperature growth potential.
3. Long term mean air temperature.
4. Long term mean air temperature growth potential.
5. Degree day sum.
6. Degree day sum growth potential.
7. Crop moisture index.
8. Crop moisture index growth potential.

It was felt that through these eight elements a predictive model had been developed.

NASA began in February 1975 to accumulate data--the necessary weather data so that an evaluation of the model could be made. To accomplish this end a Joint Evaluation Team (JET) was established by the United States Department of Agriculture (USDA) and the National Aeronautics and Space Administration (NASA) to evaluate the Screwworm Eradication Data System (SEDS) for possible implementation into the USDA, APHIS Screwworm Program. The authority for the team was based on the exchange of letters dated October 14, 1975, between Doctors Mulhern and Edminister of the USDA and Mathews of NASA after SEDS was declared operational by NASA. The principals of the evaluation team were Dr. S. C. Gartman, (Elected Chairman) Mr. George Bickerton, Dr. James Novy, and Dr. Wendell Snow of USDA and Dr. C. M. Barnes of NASA. Dr. Novy was replaced during the meetings by Dr. Chris Hofman. Dr. DelVar Peterson, and Mr. Kenneth Wissmann, both of USDA, served as technical consultants. The joint evaluation team has met seven times from August through January for periods of two-three days each and was supported by NASA and USDA civil servants as well and NASA contractors who provided technical input for discussions.

The JET responsibilities and areas of investigation were accepted as proposed in the letter from Dr. Mulhern, dated October 14, 1975, and sent to Mr. Charles Mathews of NASA. These are presented below:

1. Evaluate whether the SEDS provides reliable predictive information related to screwworm habitat.
2. Determine SEDS output product requirements.
3. Evaluate the utility of output products in field operations.
4. Provide for ground truth and historic and current insect case data to support the evaluation effort and for further model improvements.
5. Conduct a cost-benefit analysis of the SEDS utilization.
6. Define the steps leading to technology transfer, assuming favorable evaluation of the SEDS.
7. Determine the value of other field information to the screwworm eradication effort and provide the necessary information for input into SEDS.

In addition to the objectives set forth in the letter to Mr. Mathews one additional condition and a restraint was agreed to and placed on SEDS. This condition was that SEDS would provide a numerical estimate of the screwworm growth potential. The restraint was that the present model would not be modified except for elevation and emissivity corrections, substitution of the Delta T field and the routine changes in the temperature conversion or DMAT coefficients.

Approach

Although SEDS was developed as a set of weather potential functions it was presented as a predictive tool which would provide numerical estimates of screwworm growth potential (CGP) for specific geographical areas which included 90 southern Texas counties. It was felt that this estimate should be reliable to be of value to the eradication program.

In addition to the combined growth potential (CGP), the following information was requested and supplied by NASA. These were:

1. Short term mean air temperature (STMAT).
2. Short term mean air temperature growth potential (STP).
3. Long term mean air temperature (LTMAT).
4. Long term mean air temperature growth potential (LTP).
5. Crop moisture index (CMI).
6. Crop moisture index growth potential (CMP).
7. Degree day sum (MPT).
8. Degree day sum growth potential (MPTP).

SEDS was proposed to have the capability of expressing these eight products in both photographic and numeric form and was evaluated in both forms. The evaluation of the results are found in later sections of this report. However, they were carried out using the following format. The evaluation of the temperature elements was accomplished by comparing the SEDS outputs of each element with those obtained from meteorological stations referred to as ground truth

data. The validity of the crop moisture index was not evaluated, but various authorities on soil moisture were consulted. The growth potential elements were analyzed using a statistical approach and the final combined growth potential composite was analyzed by comparing predicted values from SEDS with what occurred in the field. The time intervals proposed were a spring evaluation period from March through June 1975; a fall evaluation period from October through December 1975; and a "real time" evaluation period during the spring of 1976.

It was agreed that JET would make use of all reference materials and reports of studies made by NASA staff or its SEDS contractors. Furthermore, JET would review and analyze all material available for potential impact on the SEDS evaluation.

EXECUTIVE SUMMARY OF MAJOR FINDINGS AND CONCLUSIONS

The scope of this study of the Screwworm Eradication Data System (SEDS) was comprehensive. Accordingly, the evaluation methodology was formulated in such a manner that all major aspects of the system would be addressed. A detailed discussion of each finding is presented in the section of this report entitled "Results of the Evaluation."

Temperature Estimation and Screwworm Population Dynamics

The capability of SEDS to estimate daily mean air temperature for selected ground locations is a significant part of the system under evaluation. The adjustment of radiometric values for distortions introduced in the measurement process is facilitated by accurate charts of ground elevations. Presently, elevation maps for U.S. areas are available. It is important to note that the availability of high quality elevation charts for areas in Mexico is minimal and, in some areas, nonexistent.

The registration of satellite images to reference points on the ground seems to be within the capability of current technology. Evaluation data suggest that most points used by SEDS are within ± 12 to 16 miles of the true ground reference. With regard to resolution of the satellite sensors, it has been reported that areas which are less than 12 to 14 miles square are not discernable on SEDS products. This raises doubts that certain canyons or other relatively small areas which have adequate ecology for screwworms will be identified as such by SEDS.

Currently, a NOAA satellite makes two passes per day over ground locations of interest and inputs data to SEDS. Only data which is not contaminated by cloud cover or minor mechanical system problems is usable for temperature estimation. For the spring 1975 evaluation period, it is estimated that satellite data for Texas was available, on the average, 50 percent of the time. There was, of course, some variability in these data. The lowest and highest observed averages were 31 and 83 percent. Interpretation of the 50 percent average figure should be made in light of the fact that individual ground points may yield no data for days at a time. The majority of consecutive days of missing data were in the range of 1 to 3 days for 16 selected Texas cities. A few exceptionally long periods of 18 to 20 days were observed.

When data is available, it is estimated that the SEDS daily mean air temperature is generally within ± 4 degrees centigrade of ground truth. However, it is quite possible for DMAT errors for individual locations to be 15 degrees from actual air temperature. The effects of any temperature errors are subsequently passed on to the three other temperature products which SEDS derives from DMAT.

These deficiencies significantly impact the decision making capability for which SEDS was developed.

While the above provides an expectation of the level of precision in average air temperature values, the relevance of this estimate merits, at least, further research. From an entomological perspective, air temperatures 5 feet above the ground are less critical to screwworm pupae than actual soil temperature.

Screwworm pupae respond to soil conditions and only indirectly to changes in climate above the ground. Factors such as soil moisture, and vegetative cover may indirectly influence the adult fly. With respect to the temperature effects on adult screwworm activity, it is conceivable that hourly temperature inputs might provide valuable information to the system. Findings to date indicate that available remote sensing technology does not currently provide soil temperature readings.

The Crop Moisture Index

The sole non-temperature variable used in SEDS is a composite index of evapotranspiration anomaly and soil wetness developed by Palmer (CMI). CMI is calculated for several large geographic areas and was devised to yield only a coarse measure of moisture to be generalized across the area. If SEDS products are to be used in small areas, local climate and soil variations would not be reflected in the general CMI index for the area. The manner by which CMI is presently incorporated in the SEDS predictive model does not allow soil moisture to be a limiting factor. That is, when soil moisture conditions are extreme and not supportive of screwworm populations, population growth potentials based on CMI will be estimated by SEDS to be greater than one (i.e., population growth is predicted).

The fact that CMI values are developed with regard to moisture levels typical for a climatological region introduces a problem which is, at least, controversial. CMI is a numerical value which is relative

to a region. A value of 1.6 indicates a discrepancy from the "expected" moisture in that region. Since regions do not normally have identical expected moisture levels, 1.6 CMI changes meaning from one region to another. However, the SEDS model treats these relative values as if they could be interpreted directly, across any climatological region.

The epidemiological literature does not show any direct causal relationship between moisture levels and screwworm prevalence. In fact, recent research indicates that soil moisture, within moderate tolerances, has little bearing on survival of the pupae in the soil.

Moreover, it is simplistic to assume that weather factors alone (as indexed by temperature and CMI) affect population trends in screwworm populations. Several other factors should be investigated to assess their impact on the dynamics of this insect.

The SEDS Model

The SEDS products discussed above are combined to create one overall index of screwworm growth potential. Each of the temperature products and CMI, as well as the combined index, can be obtained from SEDS for geographic areas of interest. The evaluation committee has concluded that the development of mathematical relationships for the SEDS growth potentials was done, in part, arbitrarily and in the absence of clear scientific documentation. Materials produced in the early phases of the SEDS project attest to the tentative nature of these relationships as first approximations. Necessary, scientific support (in the form of factual information from well designed research studies) is not yet available.

The SEDS model is one which makes use of statistical relationships found in the SEDS developmental studies. Data on the temperature and moisture variables are weighted according to a mathematical formula. It is clear that the high degree of overlap among the three temperature variables and the relatively low relationship of each variable to actual population growth rate are just two factors which preclude an acceptable level of predictability for this model.

An additional consideration is that confirmed case reports of screwworm are not considered to be quantitative values. Case reporting is one indicator of the presence of screwworms and the very indicator on which the SEDS model was constructed.

Setting aside a statistical argument, the model may be judged as incomplete from entomological and epidemiological points of view.

SEDS is "timed" so that short-term temperature values are keyed to a population of flies which is four-days old when the satellite makes a pass. Considering that there is a required period of time for data processing, the SEDS predictions will arrive in the hands of an epidemiologist too late to be used on that population. This may result in the release of sterile flies in areas where most population mating has already occurred. It has been suggested that variables such as the availability of host populations, food sources, vegetative cover, animal husbandry practices, persistence of wounds, rainfall, wind, relative humidity, soil types, daily temperature extremes and the activities of the USDA eradication program (sterile fly release) represent only a partial list of factors which rival the importance of temperature and relative soil moisture.

In summary, the SEDS model demonstrates a marginal relationship to screwworm population dynamics and considers a complex set of phenomena from the narrow perspective of weather alone.

Technology Transfer, Costs and Benefits of SEDS

Available documentation on SEDS is, as yet, inadequate for full transfer of technology to a new operation. A major concern raised by the committee focused on the absence of appropriate quality control mechanisms to identify when the system generated a product of unacceptable quality. It is difficult with present SEDS data to document a favorable cost-benefit ratio because the programs involved are still in a research and development stage. There is no evidence that the perceived benefits of SEDS will be realized.

Additional comments on the need for modification of the SEDS system were received from NASA contractors. Dr. Alberto Broce, LEC/NASA (15) completed a study titled "Subjective Analysis of SEDS" and concluded "In light of the present study, SEDS does not appear to be operational for field use in its present configuration."

In view of the above, it is the opinion of the committee that this system (SEDS) is not functionally operational for use by Veterinary Services in the Screwworm Program.

RESULTS OF THE EVALUATION

The Screwworm Eradication Data System is a highly structured and complex configuration. Four interrelated aspects of the system were reviewed by the Product Evaluation sub-committee and the Cost/Benefits sub-committee of the JET. The results of this evaluation will be discussed in conjunction with committee interpretation of the impact on the USDA screwworm eradication program. The four general areas are:

- A. Temperature Estimation
- B. The Crop Moisture Index
- C. The SEDS Predictive Model
- D. Technology Transfer; Costs and Benefits
- A. Temperature Estimation.

The estimation from satellite data of the daily mean air temperature is the nucleus around which the SEDS system is constructed. With the exception of the crop moisture index, all SEDS products are derived from this single measurement of air temperature for each ground location of interest. Consequently, factors affecting the reliability and validity of the estimated values must be identified and appraised in terms of difficulties to be encountered under normal system operations.

Currently, a NOAA satellite transmits radiometric temperature values in analog form over land areas of interest to the screwworm eradication effort. The conversion of these radiometric values from analog to digital form is the initial step in obtaining temperature values. The conversion process requires approximately 8 hours of data processing time for each day (2 passes) of satellite data.

The resulting temperature values are adjusted for two factors which depend on earth surface characteristics. Corrections for distortions due to local emissivity and elevation are currently operable in SEDS but the adjustments are described as relatively coarse. Some significant improvements can be effected by the addition of more highly detailed elevation charts and modification of the present SEDS software (1). Phinney (2) has commented that the level of detail in elevation maps of Mexico is less than the Texas maps currently used by SEDS. Refinement of the elevation values would improve the ability of SEDS to estimate temperatures in Mexico.

Whenever successive passes over a ground location must be integrated, there is need for a mechanism to register data to the same ground point. Phinney (3) has observed that "the quality of the registration of the radiometric data to the SEDS reference image is extremely important. Without accurate registration, no meaningful comparison can be made between surface mean air temperature and the satellite observed radiometric temperature." The registration of SEDS data seems to be within the capability of current technology. S. Boatright (4), in her report of October 16, 1975, indicated that a "best estimate" of the standard deviation for the horizontal (pixel) elements is 3.5 and for the vertical (scan) is 2.8 elements (each element is approximately 885 meters square). The "best estimate" was determined at the center of the image. The standard deviation increases from the center of the picture to the edges.

Expressing this variation in terms of land area and screwworm habitat, it means that 67% (+1 standard deviation) of the pixels are within +3100 meters ($3.5 \text{ elements} \times 885 \text{ meters/element} = 3100$ meters or 1.92 miles) of the correct ground reference point and that 67% of the scans are within 2500 meters ($2.8 \text{ elements} \times 885 \text{ meters/element} = 2500$ meters or 1.54 miles) of the correct ground reference point. Additionally, it can be assumed that 95% (+2 standard deviations) of the pixels and scans fall within +3 to 4 miles of the true ground point. SEDS does not use each pixel of the original NOAA image. Every fourth pixel is sampled and becomes a "super-pixel" for use in SEDS. Consequently, it would be expected that 95% of the registered points would fall within +12 to 16 miles of the correct ground reference point.

With regard to the resolving power of SEDS, it has been reported that areas which are less than 12 to 14 miles square are not discernable on the SEDS products. Therefore, canyons or other small areas which have adequate moisture, vegetation, and a host population and a high potential for screwworm growth may pass undetected by SEDS.

In a special study of the Reyes Canyon area (Mexico), Arp (5) used satellite temperature values to produce a detailed map of the canyon. This illustrates the potential of the system, but it should be emphasized that Arp's study was somewhat atypical. He used the individual pixels (i.e., the smallest resolution available) and not the "super-pixel" normally used by SEDS. Additionally, the

detailed map could not be obtained from every satellite pass. Out of the five passes of the Reyes Canyon, only one provided sufficient detail to support the Arp study. The other passes were contaminated due to several possible causes.

Contamination of the satellite data is often due to pervasive cloud cover in the area, or minor mechanical problems such as recorder shut-off or breaks in data transmission. Uncontaminated data is known as available satellite data. In a study of the spring 1975 SEDS data, the Product Evaluation sub-committee estimates that cloud-free data from the twice-daily satellite pass in Texas was available, on the average, 50 percent of the time. This figure varied for different sections of the country; the highest average for available data was 83 percent. The lowest was 31 percent.

Table 1 shows the availability of satellite data in 14 counties during part of April, all of May and June (1975). These data were taken from the N-Good figure on the Aeroneutronic-Ford summary of SEDS products during the evaluation period. The figures represent the percent of the "14 day average" for all pixels in the county. The counties were selected as representative of those having low, medium and high available satellite data. Most of the areas had significant increases in usable satellite data from April to June. However, four areas--Reyes, Colima, Fortin, and Cameron--decreased during this time period. (The variation is an expected seasonal variation and changes for different sections of the country.)

TABLE 1

AVERAGE PERCENT OF USABLE PIXELS AVAILABLE FOR
ESTIMATING DAILY MEAN AIR TEMPERATURES BY TIME PERIOD

<u>County</u>	<u>April 20-30</u>	<u>May 1-31</u>	<u>June 1-27</u>
Brazos	18	26	45
Colorado	17	26	46
Gonzales	15	34	53
Matagorda	20	27	45
Washington	20	27	42
Cameron	56	49	42
Gillespie	43	46	54
Hidalgo	58	56	57
Hudspeth	54	70	71
Ward	53	77	80
Jeff Davis	71	84	87
Forten	71	66	39
Colima	86	89	62
Rayones	78	66	68
Time Period Average	47.14	53.07	56.50

Table 2 shows the range of percentages for available satellite temperature. There is considerable variation from day to day for a given county as indicated in the magnitude of the range. For example, during the month of May, Brazos County had a day in which 47 percent of the satellite pixels provided good radiometric information. It also had at least one day in which only 3 percent of the pixels provided usable data. These are the extreme values for Brazos County, with the average available satellite data for May being 26 percent (Table 1).

On May 2, Colima had a high of 109 percent satellite information. This artifact was caused when the computer would not read three tapes. The JET was assured that this difficulty only affected the mechanism for tabulating usable pixels and did not affect the temperature values.

TABLE 2

MAXIMUM AND MINIMUM PERCENT OF USABLE PIXELS
AVAILABLE FOR ESTIMATING DAILY MEAN AIR TEMPERATURES BY TIME PERIOD

<u>County</u>	<u>April 20-30</u> <u>High-Low</u>	<u>May 1-31</u> <u>High-Low</u>	<u>June 1-27</u> <u>High-Low</u>
Brazos	23-16	47-3	63-22
Colorado	19-13	45-8	60-25
Gonzales	21-11	55-14	65-37
Matagorda	24-16	51-7	54-27
Washington	24-17	42-12	58-18
Cameron	65-43	67-33	60-27
Gillespie	46-40	62-35	76-36
Hidalgo	72-43	70-40	73-40
Hudspeth	74-42	80-61	89-44
Ward	77-43	89-69	96-53
Jeff Davis	87-61	99-73	101-58
Forten	79-64	97-36	46-26
Colima	96-79	109-65	71-44
Rayones	98-66	100-73	79-41

These difficulties indicate that the system is not fully operational. The error discussed above was first noted on the May 2 printout which means that all the percent satellite data figures from May 2 on, could be as much as 9 percent high.

Given the fact that satellite data is available only 50 percent of the time, a logical question is, "What is the length of the sequence of missing days?". With this in mind, a detailed investigation was done by the Product Evaluation subcommittee on satellite information over the spring test period for 16 Texas cities--Abilene, Waco, Midland, Beaumont, San Angelo, Houston, Austin, El Paso, McAllen, Brownsville, San Antonio, Marfa, Victoria, Del Rio, Cotulla, and Corpus Christi.

The night passes for Beaumont, Waco and Houston had several runs of 18 to 20 consecutive days of missing data. These three cities were more of an exception than the rule. The average run of missing data for the 16 cities was 1.6 days (the night passes for Beaumont, Waco and Houston were excluded from this average). A 9-day interval without satellite data was the maximum period other than those noted above. The majority of the runs were from 1 to 3 days.

When satellite data is available, SEDS estimates the daily mean air temperature (DMAT) for each location of interest. The details associated with estimating DMAT are described in the system documentation available at NASA. Basically, SEDS uses linear regression equations to transform the radiometric satellite data into DMAT. Four separate

equations are used to estimate DMAT depending on the availability of satellite data--i.e. (1) both day and night radiometric data usable; (2) only day radiometric data usable; (3) only night radiometric data usable; and (4) neither day nor night radiometric data usable. Coefficients for the first three equations are referred to as the DMAT coefficients and are determined and adjusted from monitoring the residual DMAT errors.

The DMAT coefficients used during the spring evaluation were derived using temperature values from U.S. and Mexico border stations. There were two different sets of DMAT coefficients used and comments were made (2) that there should have been three sets. The first set of coefficients was developed on March 15-29 data and used until June 5. The second set of coefficients were developed on the May 10-23 data but put into effect on June 5. The time lag between developing the coefficients and implementing them was due to the accelerated processing of the spring data.

With reference to the change in the coefficients during the spring processing, Phinney (6) states that "in the example from 15-29 March 1975, the Bias error for Case 3 (night radiometric data only) was $+0.52^{\circ}\text{C}$ and the rms error was 2.41°C . By 10-23 May 1975, the Bias error had changed to 1.43°C and the rms error to 3.63°C . At that time the DMAT coefficients were recalculated. For the same case, the new Bias error was 0.0°C with a rms error of 2.16°C . Thus, providing the base-line figures for the next evaluation."

In order to get the best temperature estimates it may be necessary to have separate DMAT coefficients for different areas. Phinney (6) alludes to this when he states that "the DMAT estimates for regions well away from the U.S. Mexico border area should be handled with care. The higher elevations experienced in some parts of Mexico are outside the range of data over which the DMAT coefficients were calculated." This problem of extrapolation from the data on which the SEDS model was built may very well lead to greater errors in temperature estimation in Mexico. In order to achieve more precise temperature estimation in Mexico, further research is needed to extend the range of temperature values that the SEDS model may handle with some validity.

The DMAT coefficients are extremely important in estimating the DMAT values. There are three points to be emphasized; first, the DMAT coefficients need to be exact. This requires constant monitoring of the daily temperature values by a trained professional. Secondly, the DMAT coefficients are very sensitive and can be used without change for about one month; and thirdly, the SEDS system needs to be improved to automatically change the coefficients.

Inasmuch as the SEDS model relies on linear combinations of DMAT, the predictive validity of the model depends on the accuracy of the DMAT estimates. In order to evaluate the magnitude and type of error to be expected when estimating DMAT, SEDS project staff have carefully documented errors on a weekly basis for the full spring

evaluation period. The definition of error always involves a true value against which an estimated or predicted value is compared. In the case of SEDS, true values of temperature were collected for 95 selected meteorological stations in southern Texas. For those same locations, DMAT was estimated using equations dependent on the available radiometric data for each day. The arithmetic difference between the true and estimated temperatures has been defined as error; the weekly average of these errors has been termed "bias error" in the SEDS documentation. Variability in the size of expected errors is also quite important to potential users of SEDS. The statistical measure of variability commonly referred to as the standard deviation has been calculated by the SEDS staff. This can be interpreted as a measure of spread in the error distribution (i.e., to what extent errors deviate from their central or average value.)

These two summary statistics on the error distributions are helpful to the extent that they communicate the accuracy of individual predictions to users of the system. Unfortunately, it is easy to misinterpret their meaning. In order to clarify the meaning of some typical DMAT error distributions, data were graphed for the weeks of March 29-April 4, and April 5-April 11, 1975, and is shown in Figure 1, 2, and 3. Reference to Table 3 reveals that the average observed difference between DMAT and ground temperature (bias error) is relatively small (1.5°C or less). The standard deviations for these distribution also seem "small." However, a better representation

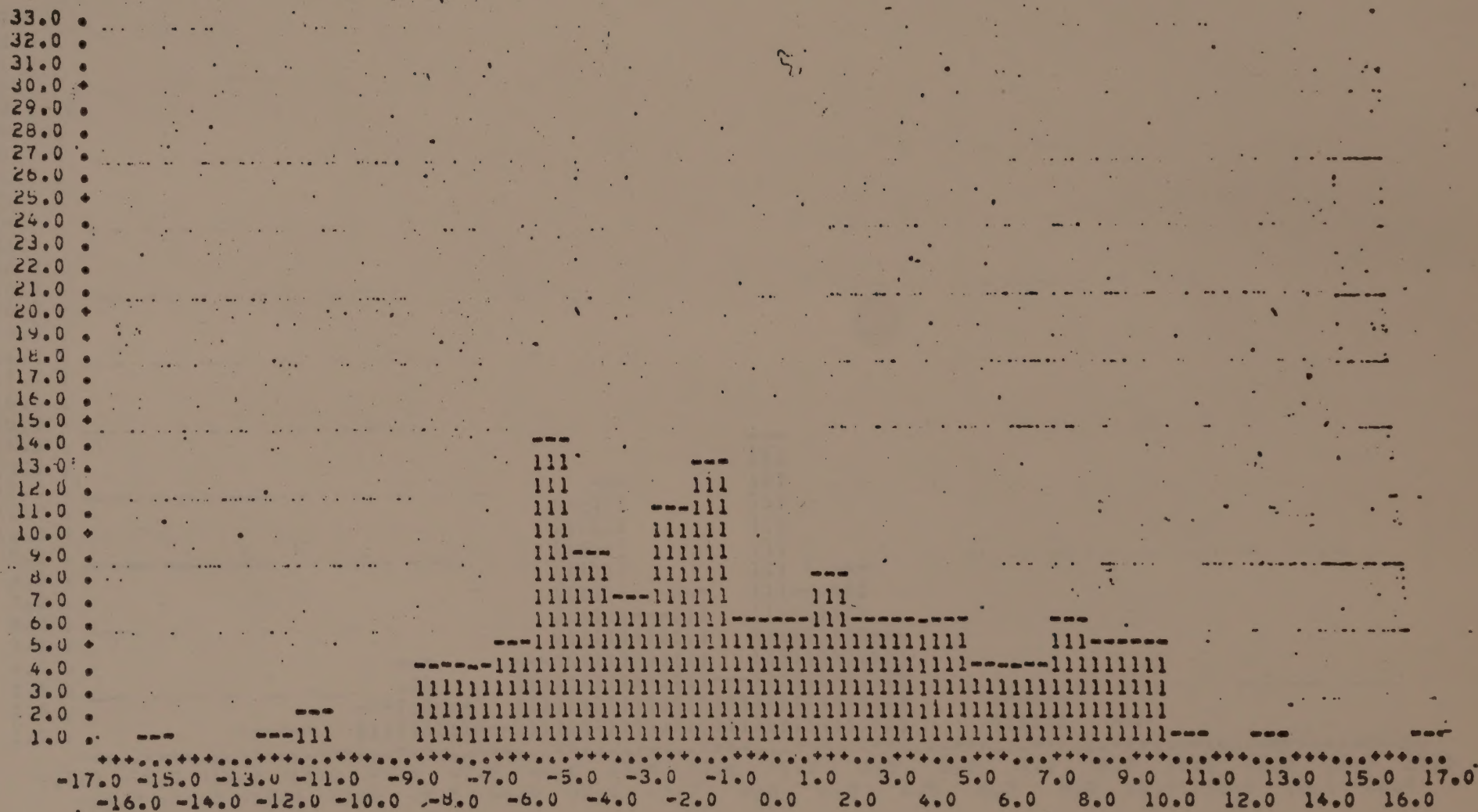


Figure 2

Distribution of DMAT Errors - Day Radiometric: March 29-April 4

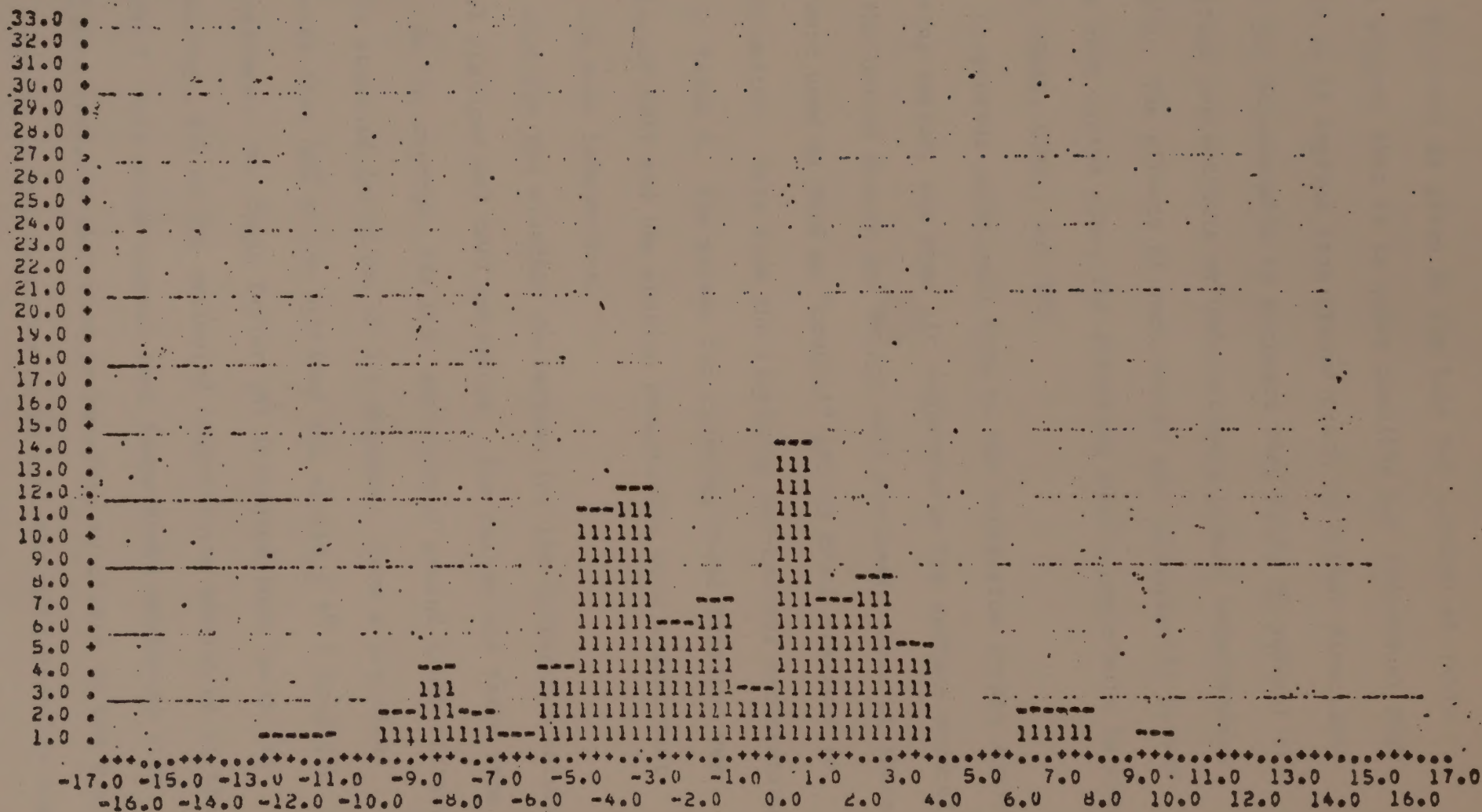


Figure 3
Distribution of DMAT Errors - Night Radiometric: March 29-April 4

of the spread of errors is given in the last two columns of Table 3. These data suggest that it is quite possible for individual DMAT errors to be 12 to 15 degrees from ground truth in either direction. In fact, it is not unreasonable to estimate that fully 25 percent of DMAT's will either overestimate or underestimate ground temperatures by more than 5°C. The effects of such errors are subsequently passed throughout the SEDS system since the distorted DMAT's contribute to growth potentials for STMAT, LTMAT, and MPT.

In order to provide additional data on the estimation errors across the entire spring period, the mean air temperatures for surface meteorological stations for the United States and Mexico were reviewed. Some of these met-stations were used by SEDS as "control" ground truth stations to verify DMAT estimates. Data from the remaining non-control met-stations are reported in Table 4. The reason for choosing these stations was that the estimated DMAT and the station temperature were independent estimates of the same temperature.

Table 4 contains the standard deviations for the difference between the noncontrol stations and DMAT estimates. The values are taken from Phinney (7). On the average, the U.S. non-control ground truth stations had an overall standard deviation of 3.1 degrees. From a practical point this means that 95% of the stations are within $\pm 6^{\circ}$ C from the station temperature. Dr. Elwin Taylor (8) indicated that "with the current technology, 95% of the estimated temperatures should be in the range of $\pm 4^{\circ}$ C." This would suggest that temperature estimates from SEDS are 50% more variable than what is possible to obtain in the U.S. Non-control stations in Mexico appear to be somewhat more variable than their U.S. counterparts.

Dates	Station Grouping	N	Bias Error (°C)	Standard Deviation	Range of Errors	Percent Exceeding + 1 Standard Deviation
April 5-11	All non-missing stations	550	-1.25	3.93	-14.7 +12.8	30
March 29- April 4	Day radiometric usable	137	- .198	6.04	-15.5, +16.1*	28
March 29- April 4	Night radiometric usable	94	-1.34	4.79	-13.0, + 9.6**	23

* Actual error of 25° was observed. Interpreted as "bad data" on 1/23/76 by SEDS project team.

** Actual error of 22° was observed. Interpreted as "bad data" on 1/23/76 by SEDS project team.

TABLE 3

Descriptive Statistics on Selected DMAT Error Distributions

Table 4

Standard Deviations for Temperature Differences in degrees C.
Between Non-control Ground Truth Stations and Estimated DMAT

Date	U.S.		Mexico	
	s	n	s	n
3/29 to 4/4	5.6	75	4.1	76
4/5-11	3.1	102	3.1	62
4/12-18	3.3	89	3.3	97
4/19-25	3.0	74	3.6	46
4/26-5/2	3.0	74	3.8	42
5/3-9	2.2	63	3.4	50
5/10-16	3.4	44	4.0	67
5/17-23	2.4	28	4.3	85
5/24-30	2.8	60	3.8	94
5/31-6/6	2.0	41	3.8	103
6/7-13	3.0	55	3.4	115
Average	3.1		3.7	

Boatright (1) indicates that modifications to the current SEDS temperature estimation may be made to improve the accuracy. An additional problem reported by Boatright is evidenced by a trend in the temperature residuals. Presently, SEDS routinely underestimates temperatures in the northern regions of the evaluation area but overestimates temperatures in the southern region (i.e., a trend for positive residuals in the north and negative residuals in the south).

It should be clear that part of the difficulty with temperature estimation is directly related to the coefficients used to create DMAT. If the coefficients (weights) used to combine satellite temperature and altitude observations are "good," the average error is expected to be near zero and the standard deviation is quite small. It is also assumed that the appropriate weighting should not change markedly over time or in response to other factors not currently measured. If a loss of accuracy in the estimates is detected by a shift in average error or increase in variability, some immediate action is indicated. A decline in accuracy may reflect a change in data quality, or the need to "update" the coefficients in response to changing meteorological conditions. Both conditions are troublesome and may be difficult to properly differentiate. The latter condition apparently occurred during the spring evaluation period and prompted a recalculation of the DMAT equations.

From the perspective of a system user, such revisions necessitate careful documentation which, to date, has not been provided by the SEDS project staff. Our preliminary appraisal of this problem suggests that the minimal required information consists of:

1. What are the criteria which determine that a change is necessary? These should be expressed in terms of limits on average error and variability of the error distribution. Additionally, is it necessary to modify the DMAT coefficients when the system is used over areas not previously reflected in the derivation of the coefficients? That is, when SEDS is used in Mexico, is there sufficient evidence supporting the accuracy of current DMAT coefficients or is a new study necessary?

2. If an update is indicated, what data must be used to insure adequate representation of the variety of meteorological conditions under which DMAT will be estimated. For example, if data is available for a full calendar year, should sampling be carried out within seasons or across the entire year? What are the characteristics of existing SEDS history files (what geographic areas and time periods covered; how often are they updated.)

3. What specific software changes are necessary to implement new DMAT coefficients?

The above mentioned difficulties involve the estimation of only one SEDS component, DMAT. The SEDS model builds on this component and attempts to identify ground locations with a high potential for screwworm population growth.

From an epidemiological point of view, there is little doubt that temperature extremes control insect populations, including screwworms. The impact of temperature upon screwworm populations, however, should be used cautiously since all the effects are not known, nor is it known

which stage in their life cycle is affected the greatest. The studies of Flitters, et. al, (9), demonstrated that under laboratory conditions a direct correlation could be assigned to the development of pupae and temperature. This information was used in the construction of the SEDS model as a component for the screwworm growth potential. However, these were laboratory tests and do not reflect natural conditions. Factors such as soil type, soil moisture, vegetative cover, and daily temperature fluctuations all would be expected to affect the rate of pupal development. Furthermore, the pupae are responding to soil temperatures, not temperatures read at 5 feet above the soil surface.

It is alarming that the SEDS model has limited provision for temperature effects on adult screwworm activity. Biological factors such as temperatures conducive for adult movement would be relevant to the dynamics of screwworm populations, including infestation rates. It is conceivable that for the model to be predictive, temperature input may have to be as an hourly input for adult activities and daily averages for pupal development.

The point is that temperature is a major component of screwworm population dynamics; however, a daily average does not give the precision which is needed nor are the secondary effects of temperature sufficiently defined for or by the model.

B. The Crop Moisture Index.

The Crop Moisture Index (CMI) is used in the SEDS model as an independent variable to represent soil moisture. Rahn and Barger (10) indicated that CMI appears to be a useful guide for estimating screwworm activity, with periods of near or above normal CMI suggesting increased screwworm infestations in the weeks ahead. They caution, however, that these responses were strongly modified by other factors, such as high temperature and the ongoing eradication program.

There are a number of concerns and possible problems with the present use of the CMI term in the SEDS model. First, Palmer (11) indicates that CMI maps present a "generalized" picture where local variations caused by the occurrence or absence of heavy rain or by soil deficiencies are not shown. With SEDS interest and intent being to identify the screwworm potential in the small, localized areas, it appears that CMI is too coarse a tool to provide the needed information for screwworm prediction.

Secondly, CMI is a combination of an evapotranspiration (ET) anomaly index and a wetness index. The general pattern of CMI is that it is at or near zero at the beginning of the growing season, and remains near zero as long as the crop moisture supply and weather are near normal. The index returns to near zero at the end of the growing season. It is quite normal for the available soil water to decrease as the crop matures. Field crops can develop under such a system but screwworms require a specific amount of water for development.

Thus, CMI indicates the moisture conditions necessary to produce the "local" crop and does not indicate the moisture requirement needed for a screwworm pupal development.

Thirdly, CMI is based upon a measure of the weekly "abnormal" ET deficits for a climatological division. This "abnormal" ET deficit is a computed value. It is an estimate of the amount by which the actual weekly ET falls short of the expected weekly ET. Palmer's (11) reason for using the "abnormal" ET as an estimate of maximum moisture needed by crops is because subhumid and semiarid regions have ET deficits much of the time during the summer. A possible difficulty with using CMI stems from the fact that it is a measure of ground moisture which is relative to a particular region. Consequently, a CMI value of zero in one region does not indicate the same amount of ground moisture as does zero in a different region. When used in the SEDS predictive model, however, CMI values which are numerically equal are regarded erroneously as representing the same quantity of ground moisture.

Fourthly, in SEDS, CMI is transformed to a crop moisture potential (CMP). The range of this growth potential is from a low of 1.2 to a high of 3.6. As a result of this transformation, it is impossible for the soil water estimator to become a limiting factor. In reality, however, soil moisture may often be the limiting factor. The transformation also shortens the range of the CMP value which will diminish its correlation with the growth product. A more useful value to use would be the untransformed CMI value.

The implicit reasoning for incorporating CMI in the SEDS model was a weak correlation between moisture levels and screwworm prevalence. There is no independent epidemiological evidence which indicates that this may be a causal relationship. Biologically, this suggests that moisture, per se, is not directly interacting in the population dynamics of screwworms. It should be suggested that there may be other factors which are more directly related to screwworm population dynamics. Available food sources, abundance of cover, or persistence of wounds are a few such factors which are indirectly related to moisture.

It has been assumed in the derivation of the SEDS model that moisture exerts its primary influence on the pupal state. There is no corroborative evidence to support this assumption. In fact there is some fragmentary evidence that soil moisture (12), within moderate tolerances, has little bearing on survival of pupae in the soil. Furthermore, additional tests recently completed (13) have demonstrated that moisture in the form of standing water has little effect on the longevity of adult flies, and suggest that adult flies derive the necessary water from alternate sources.

There is no doubt that moisture exerts an effect on screwworm populations; however, the effects are probably not direct and could be incorporated more appropriately through biological factors other than the Crop Moisture Index.

However, it is simplistic to assume that weather alone (as measured by temperature and CMI) affects population trends in screwworm populations.

In fact, Rahn and Barger (10) showed that while weather did marginally influence screwworm populations, several other factors were at work.

These factors might well include moisture in the following terms:

rainfall (apart from CMI): watersheds including riverbasins, creeks and arroyos; water tanks, vegetative types and effects of rainfall on vegetation. Additional factors which merit consideration are the effects of wind and relative humidity, since ranchers and researchers both have commented that these impact adult fly activity. All these factors should be investigated under a research mode to asses their effects on screwworm populations.

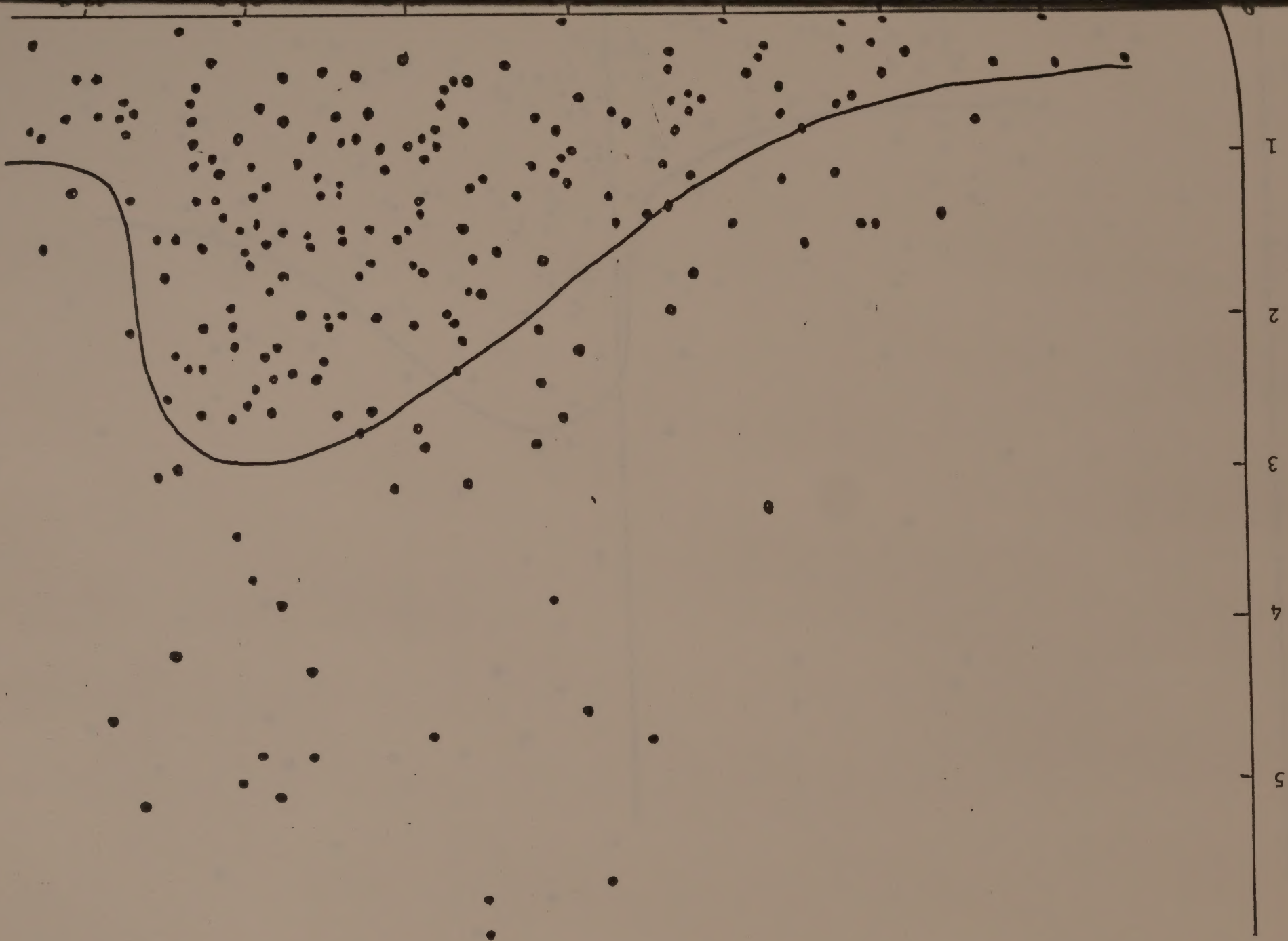
C. The SEDS Population Growth Model.

Four growth potentials or growth per generation functions are developed in SEDS. These assume that the number of screwworm cases occurring in a given week represent a given parent population. The growth per generation was defined as the ratio of the number of cases during a given week to the number of cases reported during the week in which the parent generation occurred (14).

Figures 4 and 5 (14) show the effect of temperature during the adult phase and the effect of moisture conditions during the pupal phase. The curves which represent "envelopes of potential growth" were drawn arbitrarily in the early phases of SEDS development with the intent to revise them in future analyses. To date, scientific facts from well designed research studies are not available to demonstrate these relationships. The growth potential function for short term and long term temperatures are determined from the same arbitrary temperature curve.

The amount of variation found in growth potential relationship is considerable. For example, at an average temperature of 27.5°C , the growth per generation can range from .25 to 5.0. The envelope curve was drawn so that 95 percent of the growth points would always occur below the envelope. The present use of this function incorporates so much variability that its estimated values are meaningless. The same problems exist for the CMI and MPT curves since they were constructed in a similar, arbitrary manner.

FIGURE 4
AVERAGE TEMPERATURE DURING ADULT PHASE PRIOR TO FIRST OVIPOSITION
(REDRAWN FROM PHINNEY)



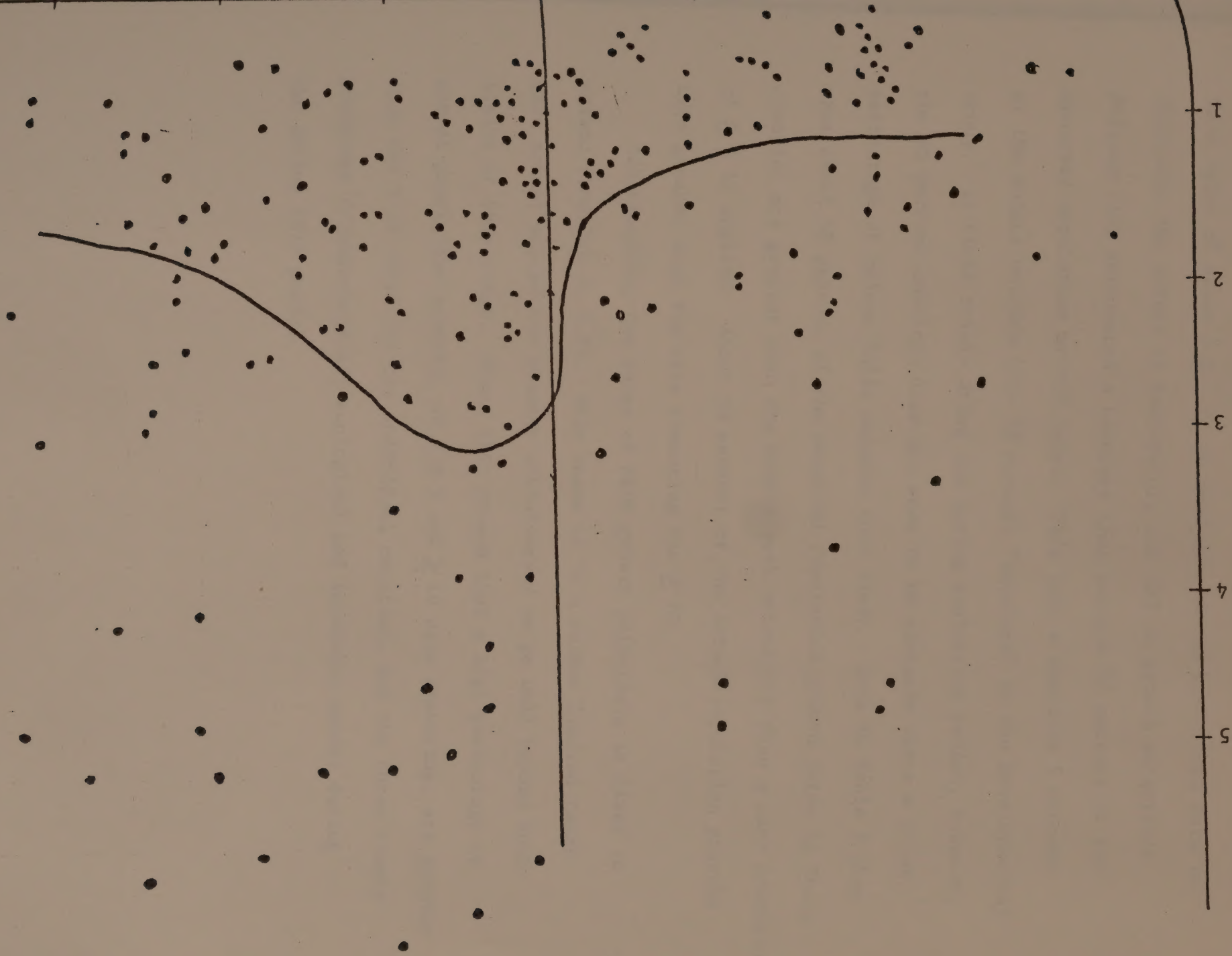


FIGURE 5
AVERAGE MOISTURE CONDITIONS AS MEASURED BY THE PALMER CROP MOISTURE INDEX
DURING THE PUPAL PHASE (REDRAWN FROM PHINNEY)

In SEDS, each of the screwworm growth potentials are maximized to a value of about 3.5. In an analysis of the historical data to determine the effect of temperature and CMI on growth potentials, Phinney (14) delineated a boundary that covered 95 percent of the observed population growth rates. This left a possible 5 percent of the points outside this 95 percent "envelope" in the developmental study. In field trials during the spring evaluation period, however, the 95 percent envelope does not seem to be adequate since a great percentage of values falls outside this limit. Data in Table 5 show that about 50 percent of the observed population growth rates in Texas counties are greater than the SEDS growth potentials when a case censoring of ≥ 5 is applied. About 39 percent of the actual population growths were greater when the case censoring was ≥ 10 .

Additionally, the range of SEDS growth potentials is fixed to extend from 0.6 to 3.55. This seems to be a rather limited range when actual population growths are observed to go well beyond both limits of this range. Broce (15) showed that a high percentage of actual population growths, at a ≥ 5 and ≥ 10 case censoring, are greater than the 3.55 limit for the individual counties, and the three county groupings (climatological, ecological and incidence zones) during the spring 1975 period.

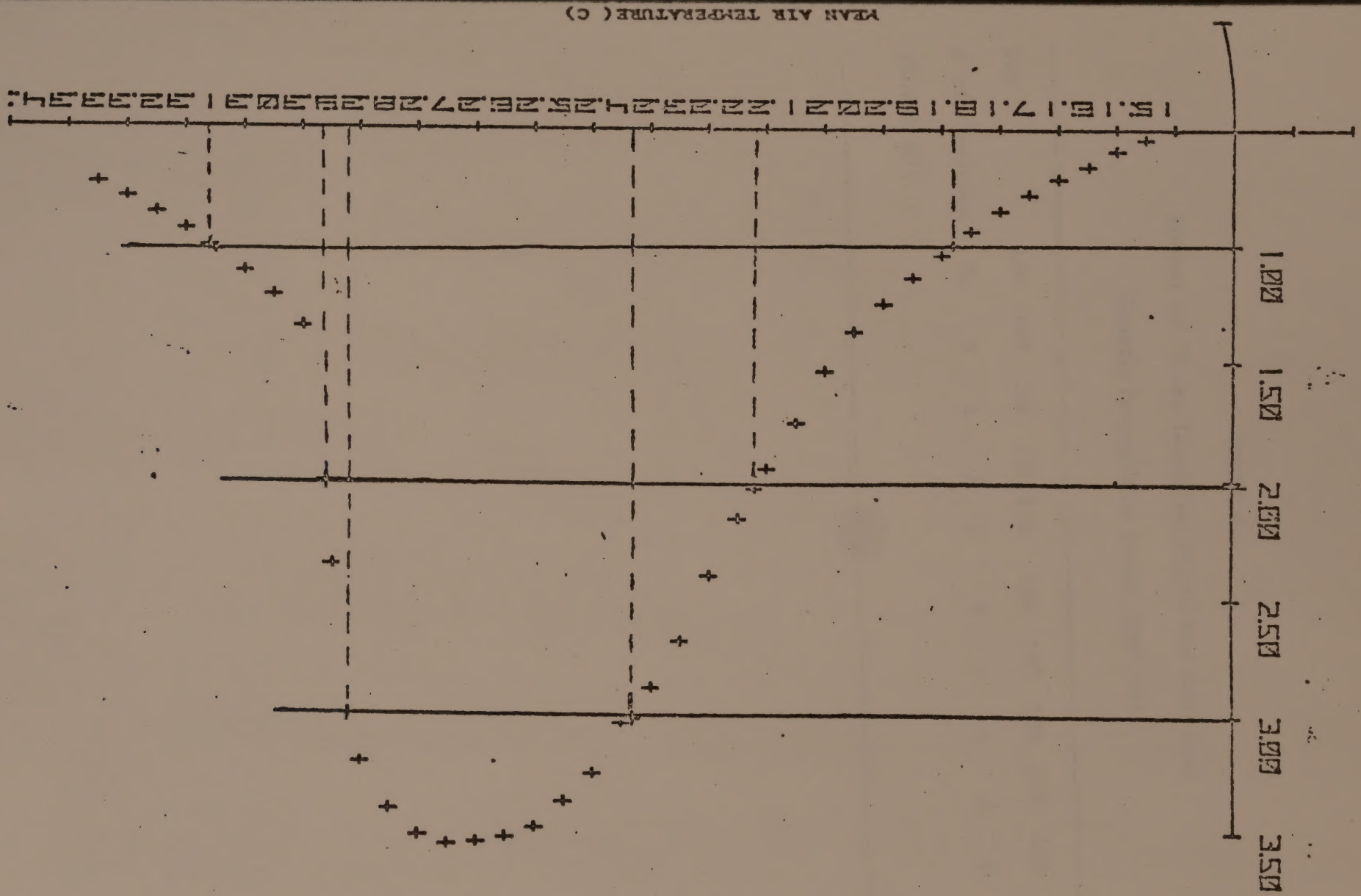
TABLE 5

Percentage of SEDS Data Base Channel Growth Potentials and Combined Growth Potentials are Greater than the Actual Growths, for Counties and Climatological Zones, Sampled 1 Per Week and Case Censorings of ≥ 5 and ≥ 10 , for the Period 3/28 to 6/25/75.

		Sample Points	STP	LTP	CMP	MPT	CGP
Counties	≥ 5	48	41.7	50.0	60.4	45.8	54.2
	≥ 10	26	26.9	42.3	43.8	34.6	42.3
Climatological	≥ 5	37	45.9	48.6	40.5	45.9	40.5
	≥ 10	30	50.0	50.0	46.7	46.7	43.3

The wide range of temperatures for which the growth potential exceeds one is a further indication of problems with the growth potential curves. As indicated in Figure 6, growth potential always exceeds unity for temperatures between 18.8 and 31.6°C. With few exceptions, temperatures in Mexico are consistently within this range. Consequently, SEDS would provide no "new" information about the potential for population growth since temperature conditions are predominantly favorable. In fact, Table 6 indicates that the number of counties within the study area in Texas that had combined growth potentials less than one were very few.

The Product Evaluation sub-committee conducted a study of data from the ARS/USDA Agriculture Experiment Station in Weslaco, Texas for the spring evaluation period. Daily mean air temperatures (as estimated by SEDS) were contrasted with average temperature calculated from hourly readings at Weslaco. Data are reported in Table 7 and indicate that differences in the two averages are relatively small. However, the differences in growth potentials calculated by the two methods show some striking differences. In one case a difference in one degree temperature indicated a difference in GP of .97 where another case with temperature difference of 2.2 degrees had a GP difference of .27. These inconsistencies are disconcerting and imply the need for more refinement and research in the SEDS system.



RELATIONSHIP BETWEEN MEAN AIR TEMPERATURE
AND GROWTH PER GENERATION

FIGURE 6

TABLE 6

Number of Texas Counties Which Had Combined
Growth Potentials Lower Than One.

Day	100	107	114	121	128	136	143	150	157	164	171	176
# of Counties	21	5	1	6	4	0	0	1	0	0	0	0
(Total 87)												

Table 7

Differences in Growth Potential Calculated
From DMAT and Hourly Average for Selected Days

SEDS Daily Mean Air Temperature (DMAT)			Daily Mean Calculated From Hourly Temperature			Temperature and GP Differences	
DMAT	Calculated MPT (Days)	DDP Growth Potential	Mean Air Tempera- ture	Calculated MPT (Days)	DDP Growth Potential	Temperature Difference	GP Difference
23.5	10.95	2.71	22.0	12.42	1.90	1.5	.81
19.9	15.29	.68	20.9	13.77	1.10	1.0	.42
19.5	15.99	.60	19.2	16.56	.56	.3	.04
20.5	14.34	.87	20.0	15.12	.70	.5	.17
24.5	10.75	3.30	23.1	11.31	2.53	1.4	.77
22.2	12.20	2.3	21.2	13.38	1.33	1.0	.97
21.9	12.53	1.82	21.4	13.12	1.38	.5	.44
22.5	11.90	2.18	22.4	11.99	2.14	.1	.04
26.7	8.75	3.57	24.5	10.15	3.30	2.2	.27
21.3	13.25	1.35	20.4	14.49	2.3	.9	.85
24.1	10.46	3.04	22.8	11.59	2.35	1.3	.69
24.4	10.23	3.20	22.5	12.45	1.81	1.9	1.39
21.5	13.00	1.50	20.8	13.91	1.05	.7	.45
22.2	12.20	2.02	21.5	13.00	1.50	.7	.57
20.8	13.91	1.05	21.1	13.50	1.25	.3	.20
25.2	9.66	3.55	24.0	10.54	2.03	1.2	1.52

The statistical analysis designed by Broce (15) sought to test the SEDS predictive model by contrasting screwworm population growth rates observed in Texas counties with growth rates as predicted by SEDS for those same counties, during the same time period. The data evaluation period began on March 28, 1975, and extended through June 13, 1975. This is a critical time period since control of the native screwworm population as it attempts to increase in size and geographical range will markedly affect the severity of outbreaks for the remainder of the season.

The mathematical model which formed the basis for a combined screwworm growth potential product was tested against available field data using the statistical technique of multiple linear regression. Historically, the form of the model and the estimates of its parameters were both derived using regression procedures. Evaluation against field data would offer evidence of the predictive validity to be expected under operating conditions. As a byproduct of the regression analysis, the relationships between and among the four variables in the SEDS model could be reexamined.

Since the SEDS model was developed on the basis of a statistical relationship between four predictor variables and population growth rate, such an analysis would determine if these relationships were maintained across time (i.e., generalizable beyond the original data base used in the model development). If so, the model could then be applied in future time periods with some acceptable level of confidence.

An additional question (not addressed by the Broce analysis due to the lack of field data) involves the generalizability of the model to other geographic locations (e.g., Mexico) beyond the areas on which the model was developed.

A measure of native fly population growth rate was constructed from screwworm case reports. Observed growth rate was expressed as the ratio between the number of cases in a given generation and the number of cases in the previous generation. Due to inherent problems in the existing case reporting system, this growth ratio was felt to be unreliable when calculated on a low number of case reports. Consequently, a case censoring of five cases per week was imposed. That is, data for an individual county would be inadmissible for analysis unless that week's case total exceeded five. Actually, a second level of censoring was also imposed setting the level at ten cases; the entire analysis was repeated under this condition.

Since data was collected over a 78-day time period for all counties, it was decided to select data at a rate of once per week for each county and use the resulting data points in the analysis. Additionally, Broce increased the sampling rate to two per week and reran the analysis to identify any differences under the two conditions.

Although data was available pixel by pixel for each county during the evaluation period, various methods of aggregation were employed to reduce the data points to a manageable number. The several ways of combining the raw data were based on defined geographical regions of interest. For example, data was aggregated to the level of a county

to coincide with ground maps of topography and ground cover. Certain combinations of counties were then formed to constitute three "zones" of interest based on ecological, climatological and screwworm incidence considerations.

Thus, when decisions based on the above are taken together, a rather complex set of analytical results is possible. Broce's analysis (15) is therefore an analysis of the predictive accuracy of the SEDS model at four levels of data aggregation, using four sampling strategies each.

Prior to examining the analytic results, a brief review of the SEDS model is presented to facilitate understanding of those results. Full documentation of the model's development and implementation is available in the SEDS literature.

THE CURRENT SEDS PREDICTIVE MODEL

The growth rate of a native population of screwworms is dependent on several factors. Currently, SEDS utilizes climatological factors alone to explain the growth rate phenomena. The SEDS model can be stated as follows:

$$GP = A_0 \text{ STP}^{A1} \text{ LTP}^{A2} \text{ CMP}^{A3} \text{ MPT}^{A4}$$

where

GP = the growth rate of the native fly population

STP = the growth potential based on short term mean air temperature

LTP = the growth potential based on long term mean air temperature

CMP = the growth potential based on the soil moisture of the area

MPT = the growth potential based on an estimate of the screwworm's
mean pupation time

A_i for $i = 0, \dots, 4$ are the parameters (coefficients) to be estimated for the model.

This has been called the multiplicative model in the SEDS literature and was chosen from other model forms as a "best" fit to the screwworm data available at that time. The model is intrinsically linear in the sense that the coefficients (the A_i) can be estimated using standard linear regression techniques. When the model was developed, analysis of historical data suggested that a set of coefficients providing a fit to the data could be specified as follows:

$$GP = STP \cdot 46 \quad LTP^{-.22} \quad CMP \cdot 36 \quad MPT \cdot 40$$

Some of the properties of this model deserve comment. The coefficient, A_0 , has been set equal to one although the rationale behind this is not specified. Additionally, since the maximum value of any growth potential term on the right side is 3.5 and the superscripts sum to 1.00, the maximum value of the combined screwworm growth potential on the left side, GP, is fixed at 3.5. One should note that field data on native populations illustrate growth rates considerably over ten. Therefore, at the outset, model users should be cautious to interpret combined growth potentials a qualitative way as high or low. Rigid adherence to a quantitative interpretation of the numerical values may grossly misrepresent actual growth rates at the upper end of the scale.

According to results presented by Phinney (2) using the historical (normative) data the multiplicative model showed a correlation of $R = .50$ with actual field growth rates. The interpretation of this multiple correlation coefficient exactly parallels that of the regular correlation coefficient: its square indicates the proportion of variability in population growth rate accounted for by its linear regression on the various predictors in the normative sample. It is important to realize that the "proportion of variability accounted for" represented by R^2 (in this case .25) refers only to what is true of the particular sample used in constructing the regression equation. There will almost always be some decrease in the corresponding proportion for subsequent samples. This is why it is necessary to cross-validate the regression equation on an independent sample in order to get a more accurate estimate of the efficiency of actual predictions by the equation.

A criticism often made about linear regression models is that they can be forced to fit almost any set of data thereby giving the appearance of being useful. This statement is not entirely true. The historical data for SEDS illustrates a case where even the "best" regression fit leaves a considerable amount of unexplained variance which can only serve to increase errors when SEDS is used as a predictive tool. The validity of the criticism lies with the fact that estimates of parameters (coefficients) in regression equations are notoriously unstable. Therefore, results from developmental regression models can only be considered as tentative results which gain in validity when they are confirmed by repeated use with new data. The ability

to generalize is increased when the results are substantiated in other locations, and at other time periods. Therefore, field tests within the expected operating environment are the primary source of evidence for appraising a model's usefulness. The spring evaluation period provided a first test of SEDS potential to predict population growth rates in native screwworms.

The ability of a linear combination of variables to predict a criterion depends on the correlations of each predictor variable with that criterion. That is, the use of a variable which is highly correlated with the criterion offers the most promise for accurate predictions. When data on several such "good" predictors are to be combined, the relationships among those predictors assume some importance. From several points of view, the selection of predictor variables which are independent of each other but highly correlated with the criterion is most desirable. In such a case, each predictor variable is adding somewhat unique information (i.e., not contained in the other predictors) to the predictions. When predictors are highly correlated with each other, an overlap of information occurs; one predictor can be used in place of another without a substantial loss of prediction accuracy.

Table 8 illustrates the type of overlap found in the four SEDS predictors during the spring evaluation period. Four intercorrelation matrices are presented since four groupings of the county data were

COUNTIES				ECOLOGICAL					
	LTP	CMP	MPT	AGR *		LTP	CMP	MPT	AGR
ST	.84	.56	.86	.25		.87	.63	.88	.29
LTP		.75	.99	.19			.76	.99	.20
CMP			.73	.03				.75	.09
MPI				.21					.23

	CLIMATOLOGICAL					INCIDENCE			
	LTP	CMP	MPT	AGR		LTP	CMP	MPT	AGR
ST	.86	.67	.83	.37		.84	.43	.84	.30
LTP		.82	.99	.38			.55	.99	.20
CMP			.81	.24				.55	-.04
MPT				.41					.22

* AGR refers to actual growth rate observed in the evaluation areas.

Table 8

Intercorrelation Matrices of SEDS Predictor and Criterion (AGR) Variables by Zone

made in the analysis. There is obvious regularity in the inter-correlations shown.* One can see that the predictors (STP, LTP, CMP, and MPT) are moderately correlated with each other, suggesting that each is not a source of unique information for making accurate predictions. Moreover, the overlap between LTP and MPT is almost total ($r = .99$), indicating that no loss of prediction accuracy would result if one or the other were dropped from the model. This result should not be totally unexpected given the knowledge that each of the temperature variables (LTMAT, STMAT) were calculated from one temperature (DMAT). Additionally, MPT was calculated directly from LTMAT and cannot, therefore, contain any information not contained in LTMAT (i.e., MPT is redundant).

The most disturbing finding from these correlation matrices, however, is the evidence on the predictor-criterion relationship. The growth rates of native populations, is denoted as AGR in Table 8. Clearly, no predictor variable shows even a moderate linear relationship with actual growth rate (AGR). This lack of relationship will effectively prohibit the SEDS model from making predictions of screwworm population growth rates with any acceptable degree of accuracy. At this stage of the analysis, a conclusion that the model suffers from rather severe deficiencies would not be unreasonable.

* The data illustrated here resulted from a sampling strategy of two days per week when weekly case reports equaled or exceeded ten. Inter-correlation based on other sampling strategies are quite similar.

When the SEDS multiplicative model was used to predict population growth rates in the field, the results were disappointing. Depending on the way in which county data was grouped (i.e., the various zone specifications), the sample multiple correlation coefficients were in the range .24 - .49 with many of these values between .35 and .49. Statistical tests on these coefficients concluded that most were not significantly different from zero (no correlation). The most optimistic interpretation of this data would conclude that, at best, only 25 percent of what contributes to screwworm population growth is represented in the SEDS model. Consequently, the remaining 75 percent of that variability is due to factors not measured by the SEDS system and not in the model. This unexplained variability will contribute to considerable error in any predictions of screwworm population growth made by the SEDS model.

Another problem with the model is the fixed time period for adult maturation. SEDS timing with a given screwworm generation is such that the population is four days old on the last satellite pass. The STMAT parameter is a running average of the temperature affecting these flies for the previous four days. By this time this population of flies is mating or has already done so. Considering that there is a required period of time for data processing, the data will arrive to the epidemiologist too late to be used on that population. Thus, the distribution of sterile flies based on the SEDS predictions would result in the release of flies in areas where the population has already mated (15).

Sexual maturation and preoviposition time are biological processes in insects that are temperature dependent. Therefore, it seems inappropriate to model an insect activity and have a set predictive time, especially when this setting is related to the most vital link in the whole eradication method: the placement of the sterile males in the field at the right time.

Two important biological properties of the screwworm populations make it extremely difficult to model, especially since little is known ecologically and behaviorally about the pest. First, very few insects of economic, medical or veterinary importance occur in such low densities yet cause such great damage. These low densities present special problems for the study of this insect. The low density problem magnifies the unreliability associated with the only population trend estimator, the case reporting system.

Second, in many seasons the screwworm in Texas may be considered as an invading population. With the warming temperatures in the spring and summer areas which were free of screwworm become suitable for the invasion and establishing of populations. Any model developed under these circumstances would be only applicable to areas with similar invading population characteristics, in which the effect of immigration of individuals is accounted for and taken into consideration. For example, Mexico has a continuous population of screwworms suggesting the need for model revisions to accomodate this fact.

The screwworm population model developed by Phinney (6) for the SEDS used case incidence data from Texas since the beginning of the eradication program. The data came from areas that are subjected each year to the release of sterile flies. However, the effect of the released sterile flies upon the natural population, as measured by the case incidence, has varied tremendously through the years. The case incidence has fluctuated from as low as 92 cases in 1970 to 8900 in 1973, to a maximum of 90,000 in 1972, which was considered a "non-normal" year. The 1975 infestation was 16,764 confirmed cases. Figure 7 (16) shows the monthly reported cases in Texas since the start of the eradication program.

Since the release of sterile flies in Texas is an ad hoc and not a preprogramed operation, it has proved impossible to determine its effects on the screwworm populations of different areas.

The screwworm case reports sent in by the public and confirmed by APHIS are a very important part of the screwworm program and the SEDS model. Because of their importance, it is vital to have an understanding of their use and the inferences, if any, that can be drawn from them. The confirmed screwworm cases are qualitative values. They indicate the presence of screwworms but the values are not quantitative. The cases cannot be used as a direct indication of the total screwworm population or the number of cases actually occurring. There is considerable information in the case reports but it must be used carefully.

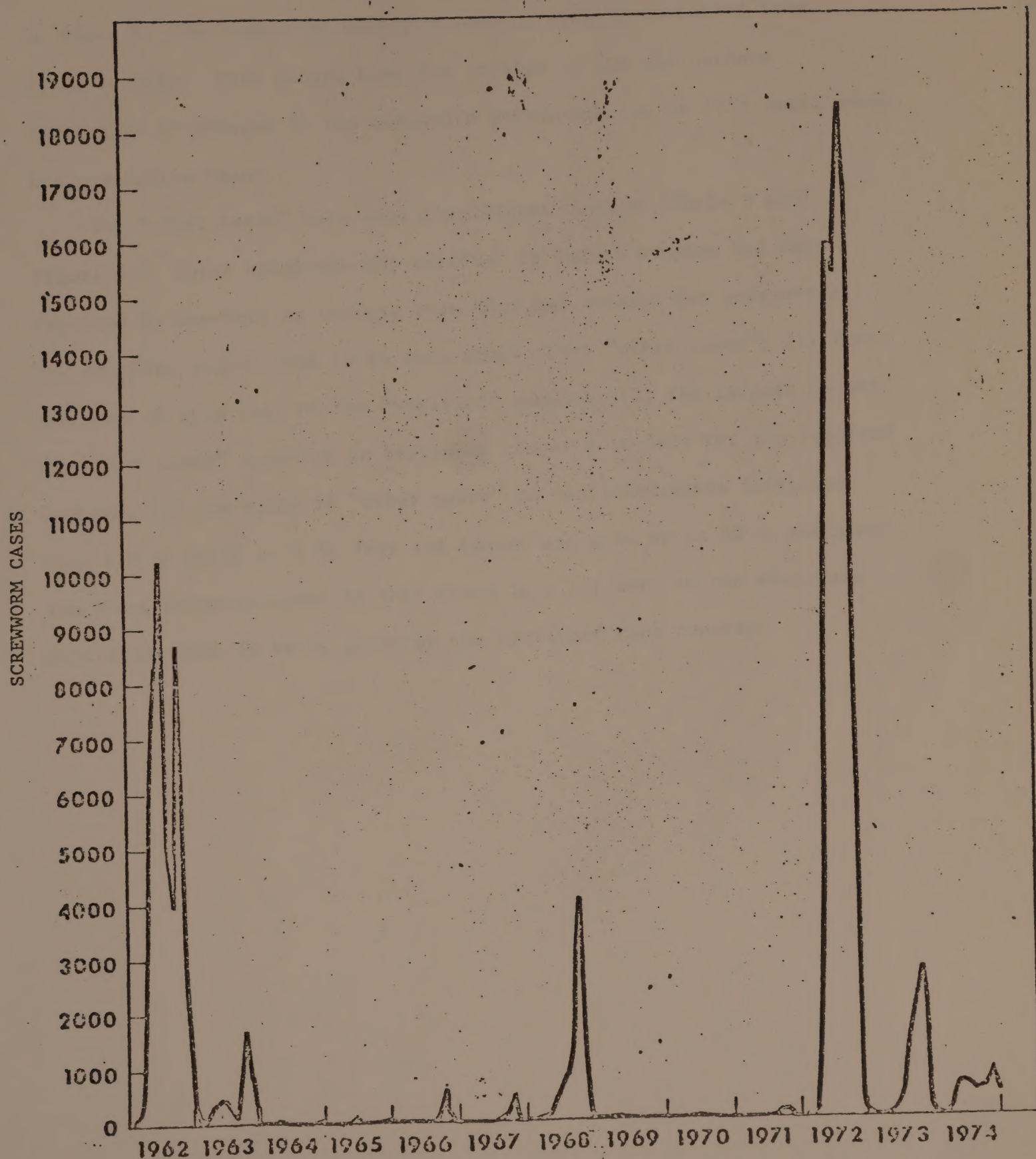


Figure 7. MONTHLY SCREWORM CASES FOR TEXAS
(from Phinney, IEC Rept. 5987, 1975)

A record of weekly screwworm cases from Kenedy County is found in Table 9. The number of weekly screwworm samples increased from April to July. This change from low to high to low was perhaps indicative of changes in the screwworm population and in this small sense has quantative value.

The "other cases" have some significant meaning (Table 9 and Figure 8.) These cases are not verified by larval samples but were reported by ranchers as animals that they had treated for screwworms. Two or three points need to be made about these "other cases": (1) There are more of them than of the "verified" samples, (2) the largest number of "other cases" appeared in September compared to July for the reported samples, (3) the ratio of "other cases" to confirmed cases increases from 1.5 in April to 3 in July and August and goes up to 20 in September. The point being stressed is that there is a lot more to the screwworm population than is being given by the confirmed case reports.

FIGURE 8
SCREWWORM CASE REPORTS 1975: KENEDY COUNTY, TEXAS

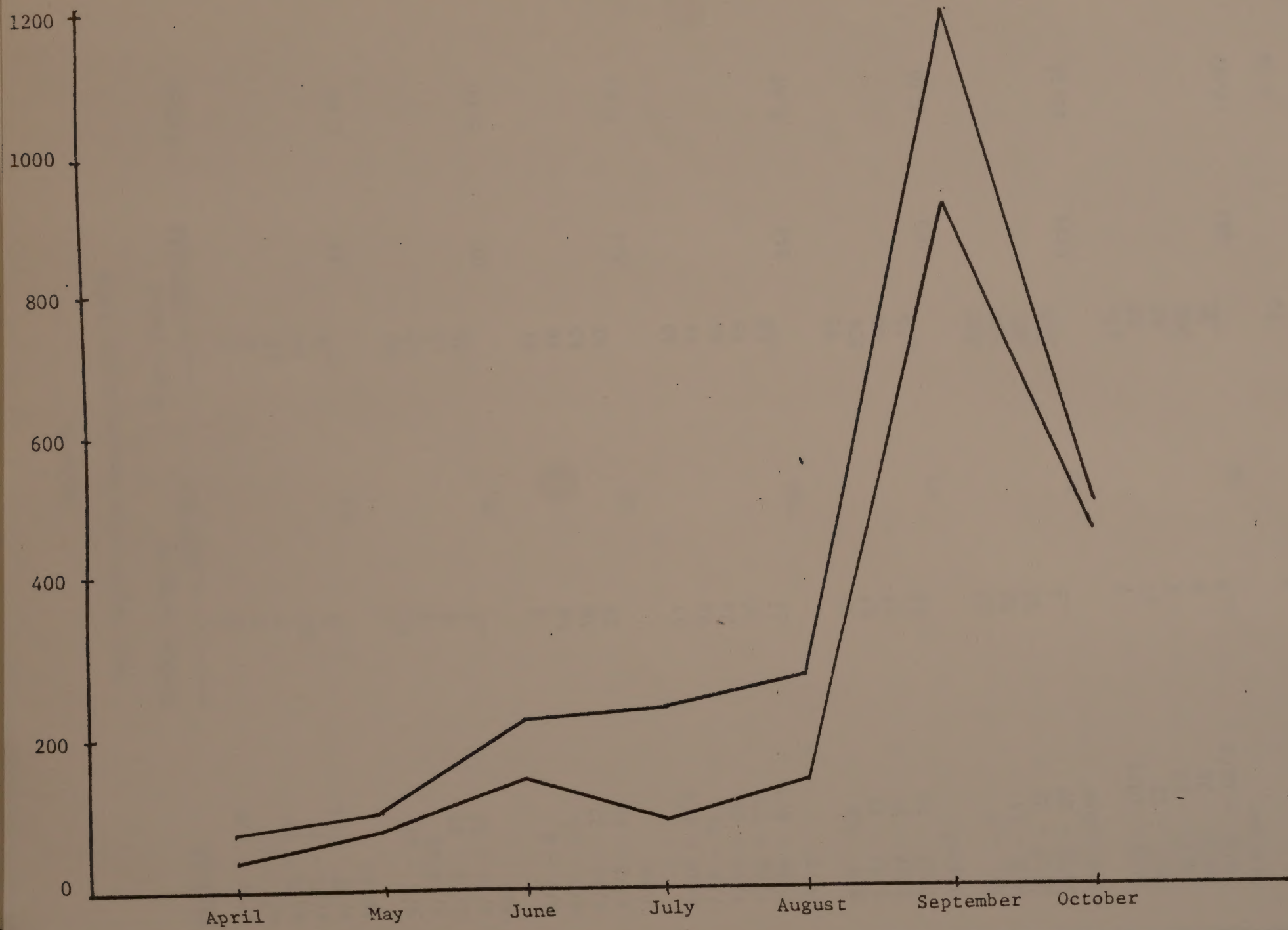


Table 9

Case Reports for Kenedy County 1975

<u>Week of</u>	<u>Weekly Samples</u> <u>Monthly</u>	<u>Other Cases</u> <u>Monthly</u>	<u>Ratio</u>
3/31 - 4/6	3	7	
4/7 - 13	0	0	
4/14 - 20	7	12	
4/21 - 27	10	14	
4/28 - 5/4	<u>3</u>	<u>4</u>	
April	23	37	1.61
5/5 - 11	12	39	
5/12-18	9	17	
5/19 - 25	6	15	
5/26 - 6/1	<u>7</u>	<u>31</u>	
May	34	102	3.00
6/2 - 8	9	41	
6/9 - 15	18	56	
6/16 - 22	16	65	
6/23 - 29	22	62	
June	65	224	3.45
6/30 - 7/6	17	38	
7/7 - 13	22	54	
7/14 - 20	24	65	
7/21 - 27	20	45	
7/28 - 8/3	<u>17</u>	<u>40</u>	
July	100	242	2.42
8/4 - 10	24	82	
8/11 - 17	17	104	
8/18 - 24	19	44	
8/25 - 31	<u>19</u>	<u>55</u>	
August	79	285	3.61
9/1 - 7	17	260	
9/8 - 14	16	358	
9/15 - 21	16	281	
9/22 - 28	<u>4</u>	<u>326</u>	
September	53	1225	23.11
9/29 - 10/5	7	174	
10/6 - 12	12	29	
10/13 - 19	7	47	
10/20 - 26	6	201	
10/27 - 11/2	<u>6</u>	<u>36</u>	
October	38	487	12.82
11/3 - 9	9	70	7.78
Total	401	2676	6.66

It is of interest to follow the identified nonscrewworm cases. APHIS's records indicate that they remain quite constant throughout the year. Implications from this is that the increase in "other cases" is mostly screwworm.

It appears to be an accepted philosophy that when the screwworm cases get bad the proportion reported drops off. This is suggested in the ratio of "other cases" to "verified cases" during the summer and fall months. Many ranchers have admitted that they do not report every case and some ranchers do not send in any.

Another problem in using verified screwworm cases as quantitative information to estimate growth is the date of sample identification. Table 10 contains data showing relationships between the reporting or identification date to sample collecting date. Although only two dates in October are shown, these results are very typical. The cases identified and reported on a given date were actually collected some 5 to 15 days earlier. This little problem was corrected for some of the final evaluations of SEDS but the growth potential relationships were developed using the case identification date.

Very simple examples have been used to discuss and evaluate the date of reporting and "verified cases" vs. "other cases;" however, the evidence is sufficient to make the point that verified case reports are at best qualitative estimators and not quantitative. Any relationship which purports to estimate quantitative information from undadjusted verified case reports is unsound.

Table 10
 CONFIRMED (IDENTIFIED) SCREWORM SAMPLES AND "OTHER" SAMPLES

Date Sample Identified	Total	October			Date of Collecting										Earlier than 10/7	Non Screwworm			
		25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10		
10/21/75																			
No. Samples	168						30	51	54	18	3	3	1	1	2	1	3	7	2
No. Other Cases	223						16	54	109	6	0	10	15	0	8	0	0		
10/27/75																			
No. Samples	103	1	19	38	21	8	6	2		2	1	1							1
No. Other Cases	304	0	7	259	23	3	3	3		6	0	0							

Furthermore, the model uses verified larvae as a quantitative estimate of screwworm presence. This fails to recognize that larvae and adults exist in completely different environments which may or may not be independent from one another. When a case is confirmed there is no way of knowing if the case is due to a migrant fly, an infested animal who was relocated an extensive distance from the initial infestation, or due to a fly existing in that immediate environment. Additionally, it must be recalled that a positive sample indicates only that a case existed in that area. The converse may or may not be true, i.e. no sample submissions from a given area do not necessarily indicate there are no cases, only that none has been submitted.

The presence or absence of suitable hosts and the incidence of wounds has long been accepted as the major component in the life cycle of screwworms and, in fact, is used as a major method for controlling screwworm populations. The importance of the presence of wounds can be exemplified by the years of 1973 and 1975 which would have had a low screwworm incidence had it not been for the outbreak of the Gulf Coast Ear Tick (*Amblyomma maculatum*) which created an abundance of ovipositional sites. Even in bad years, such as 1972, Bruce (17) reports that ranchers who were able to control and limit wounds were not seriously affected by screwworms. Lindquist (18) has shown that the presence of wildlife and their activities (such as fawning) affect screwworm populations.

The physiological state of the wound apparently affects the attractiveness of the wounds to gravid screwworm females. For example, new-born calf navels are highly susceptible to infestation, while dehorning wounds are less so. An infested wound is more highly attractive to screwworm females than one which is uninfested. The point is that there can be no screwworms where there are no wounds; there can be no wounds where there are no animals. Additionally, wounds are not identical, some wound types are at a higher risk than others. Unfortunately, only limited information is available concerning livestock, wildlife, and the number of each which are a risk at any given time. The present model of SEDS has completely ignored these factors. There is little doubt that they are extremely important in screwworm population dynamics; furthermore, it is not unreasonable to assume that this set of factors alone would determine the success or failure of the SEDS to predict screwworm populations.

D. Technology Transfer; Costs and Benefits

The principal charter of the Benefit-Cost subgroup was to conduct a benefit-cost analysis of SEDS if it was an operational system. The analysis was to be based on the findings of the Product Evaluation subgroup coupled with findings of the Benefit-Cost subgroup in the areas of automation and technology transfer.

In approaching the project the subgroup was aware of the following facts:

1. The sterile screwworm fly technique of eradicating and controlling screwworm has been tested and proven effective. The United States has been freed of self-sustaining screwworm fly population.
2. At present screwworm migration into the United States is controlled by maintaining a sterile fly barrier. The barrier is a designated area presently extending along the Mexico-United States border from the Gulf of Mexico to the Pacific Ocean. Periodically conditions become extremely favorable for the propagation of screwworms and massive outbreaks occur in the United States (1972).
3. The number of flies dropped in the barrier varies according to seasons of the year; climatic conditions during the year; and field survey reports on the numbers and locations of native fly populations especially in northern Mexico. High concentrations of sterile flies are released in areas where outbreaks have occurred, along river courses, and other areas where conditions are favorable for the propagation of native screwworms.

4. During FY 1976 the annual costs of maintaining the present barrier along the U.S. border and losses to the U.S and Mexico are expected to reach \$51.2 million. Inflation and increased numbers of screwworm outbreaks over the past several years have greatly affected the cost of the screwworm program. The total cost of maintaining the U.S. barrier in FY 1974 was \$11.7 million, \$13.4 million in FY 1975, and is expected to cost \$14.0 million in FY 1976.

5. In FY 1973 Congress approved and appropriated funds to begin a U.S.-Mexico Screwworm Program with the objectives of eradicating screwworms from Mexico and establishing a barrier at the Isthmus of Tehuantepec in southern Mexico. A study carried out by the U.S. Department of Agriculture and the Ministry of Agriculture and Livestock of Mexico in 1966 indicated that such a program was feasible.

6. In 1973 a suitable site for the plant was located and in 1975 a clear title to the land was obtained. Construction of the plant has begun and is expected to be completed and in full production in FY 1977. It is expected that eradication of screwworms can be completed by 1982. The cost to eradicate screwworms in Mexico is projected to be about \$129.3 million. Once screwworms are eradicated, the cost to maintain the new barrier is expected to be about \$2.7 million. About \$476,000 will be needed to eradicate spot outbreaks that occur once the barrier is established.

7. Projected annual costs plus losses to the U.S. and Mexico can be reduced from \$54.5 million to \$3.4 million by the year 1982 with a Joint U.S.-Mexico Screwworm Program. For the period covering from 1973-1981, the total cost of the program would be \$232.9 million--\$104.6 million above costs to continue the present U.S. Barrier Program.

8. The cost of maintaining the new barrier and eradicating spot outbreaks of screwworms would be about \$3.2 million--\$12.4 million below the expected annual cost of the U.S. Barrier.

9. The breakeven point of the new program is projected to occur in 1981 when the cumulative costs plus losses to the U.S. and Mexico would fall below the projected costs plus losses expected in the U.S. and Mexico if the U.S. Barrier program is continued. (See Figure 9, and Table 11.) The benefit-cost ratio of a U.S.-Mexico Eradication Program versus the U.S. Barrier Program is 3.01 using a 10 percent discount rate.

10. A program to eradicate screwworm in Mexico would lead to a sharp reduction in costs and losses under the U.S. Barrier program--about \$236 million by the end of 1985. Since the program has been tested and proven, there is a high probability that eradication can be achieved in the given time frame providing that full production of flies can be accomplished by FY 1977.

Fig. 9 Cumulative costs plus losses to U.S. and Mexico for U.S. Barrier (Line A) and U.S.-Mexico Program (Line B).

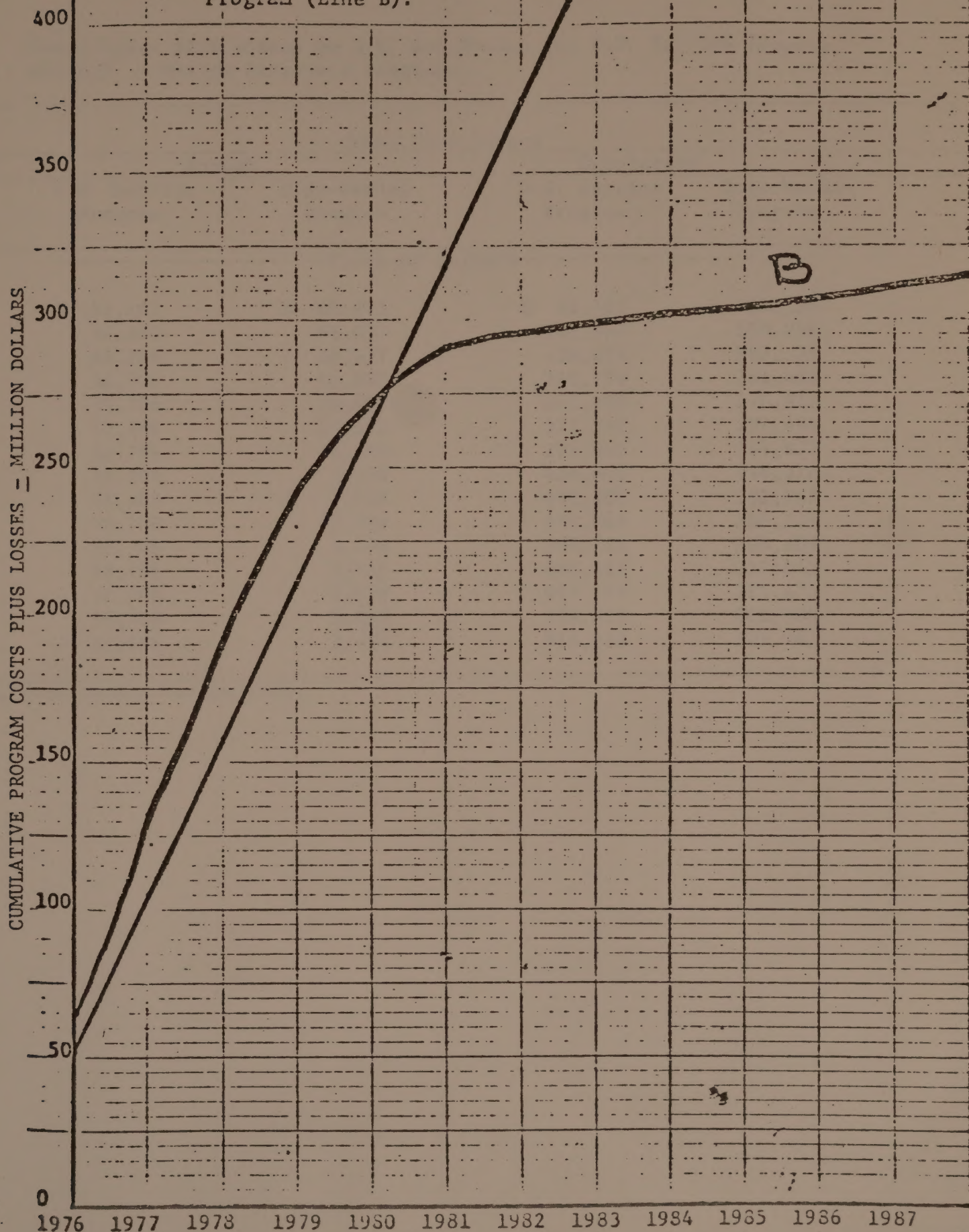


Table 11

Total Costs plus Losses to U.S. and Mexico for U.S. Barrier Program
and U.S. - Mexico Screwworm Programs.

Year	Costs Plus Losses			
	Annual		Cumulative	
	U.S. Barrier Program	U.S.-Mexico Program	U.S. Barrier Program	U.S.-Mexico Program
-----Thousand Dollars-----				
1976	\$ 51,161	\$ 64,421	\$ 51,161	\$ 64,121
1977	54,206	68,637	105,367	133,058
1978	52,706	59,537	158,073	192,595
1979	52,706	48,827	210,779	241,422
1980	52,706	29,491	263,485	270,913
1981*	59,706	20,531	323,191	291,444
1982	52,706	3,433	375,897	294,877
1983	52,706	3,433	428,603	298,310
1984	52,706	3,433	481,309	301,743
1985	59,706	3,433	541,015	305,176
1986	52,706	3,433	593,721	308,609
1987	52,706	3,433	646,427	312,042
1988	52,706	3,433	699,133	315,475
1989	59,706	3,433	758,833	318,908
1990	54,456	3,433	813,289	322,341

Breakeven occurs during 1981.

11. The Lincoln-Eden Report (19) issued in 1974 stated in part "there is no question in our minds but that the Screwworm Program has resulted in tremendous returns to the nation." This conclusion was based in part on the findings of a study by Dr. Tom Prater, Agricultural Economist, Texas A&M University and Dr. John Goodwin, Oklahoma State Department of Agriculture which showed a 1:113 cost-benefit ratio for the Screwworm Program for FY 1973. Another study conducted by Dr. Edward Uvacek, Jr., Livestock Marketing Specialist at Texas A&M at the request of Drs. Lincoln and Eden showed a cost-benefit ratio of 1:39. The lower ratio reflected a more elastic demand curve for beef, yielding a closer relationship between consumption change and price change than presented in the Prater-Goodwin study.

The preceding facts clearly indicate that the current system for eradicating and controlling screwworm has been both successful and cost effective.

The main purpose therefore of considering SEDS was to determine if the time frame for carrying out the program could be significantly reduced, thus resulting in even greater savings.

The benefit-cost analysis was to be conducted if SEDS was operational applying the definition of operational found in Appendix 14 of the Requirements Implementation Analysis Instructions (20) which were developed for use by the USDA Remote Sensing User Requirements Task Force, chartered in August 1973. The USDA members of the SEDS Joint Evaluation Team concluded that SEDS was not operational. Operational is defined as follows:

"Technology is well established, known, used or understood by at least a cadre of USDA employees. This familiarity with new technology is acquired through trial use and evaluation or operational simulations conducted in developmental phases. For operational status commercial capability exists to collect new data, required hardware and communication facilities are in place or available, and software is developed and available for routine use."

During the preliminary factfinding stages, several observations were made. Due to the significance and relevance of this information, it has been incorporated in this section of the report.

SEDS produces information. The value of this information is dependent upon the planner's ability to interpret the color-coded maps or a numerical estimate. It then becomes a decision tool which, if rightly interpreted and collated with other biologic information, such as case reports and operational delivery capabilities, could produce a return to the program and to the livestock industry. If the SEDS information is not reliable or is misinterpreted, losses can result from wasted flies or by allowing unidentified populations to flourish.

The output of the SEDS is a color-coded series of computer-produced map images of Mexico and the southwestern United States. The maps are reproduced by use of a photographic process. The key product is a map which combines temperature, soil moisture and degree day accounting. This is correlated to tolerances of the screwworm fly in its life cycle phases to these combined weather factors. Areas on the map coded in red identify those geographic places which have experienced a period of weather highly favorable to the proliferation of screwworm flies. Several problems identified are:

1. Those areas known to be free of the pest, are not eliminated.

2. Biologic considerations such as presence of host animals and availability of wounds are not incorporated into the model.

3. The accuracy of the weather information is periodically distorted by cloud cover at the time of the satellite pass.

4. The temperatures are those at the time of observation. This could miss the potentially lethal high and low temperatures of the day.

It is difficult with present SEDS data to document a favorable cost-benefit ratio because the programs involved are still in a research and development stage. There is no evidence that the perceived benefits of SEDS will be realized.

The principal benefits of SEDS as a concept are:

1. Increased geographic coverage.

2. Detail.

3. Reliability.

4. Frequency.

5. Information acquisition otherwise unobtainable in Mexico.

The hope was that SEDS information alone could shorten the time required to eradicate the screwworm fly from Mexico to the new barrier. Early completion of this task would indeed be cost-effective but was dependent upon an operating SEDS. A secondary multiplier effect would be savings resulting from prevention of livestock losses and labor cost for infested animal handling and treatment.

There is no firm evidence that SEDS will enable a shorter eradication plan. The arguments that a savings will result are subjective and judgemental.

If funding for SEDS were made available from APHIS, it should be treated as an additional cost to the Program.

Assuming that APHIS would wish to continue operation of SEDS, the lowest cost method to accomplish this is by use of outside services. Aeroneutronic Ford, one of the current SEDS contractors, submitted an unsolicited bid to perform SEDS processing including personnel and equipment for \$390,000 per year. This estimate was based upon the products, support services and processing intervals currently performed by NASA. It should be noted that the current NASA processing has a lag time of eight days caused by tapes mailed from either the East or West coasts. This lag time is operationally unacceptable for fly drop planning. The delay could be eliminated by acquisition and installation of an antenna to receive the data from the satellite in Houston. In order to make the processing timely, an estimated additional investment of \$350,000 for purchase of an antenna would be needed. This would be a one-time start-up cost. The vendor estimate is in line with NASA budgets for this project. The NASA budgets were as follows:

1972	--	\$224,000
1973	--	\$257,000
1974	--	\$201,000
1975	--	\$271,000
1976	--	\$315,000

As an alternative to vendor supplied service, the cost for APHIS to assume in-house operational responsibility were estimated in Table 12.

TABLE 12

ESTIMATED COSTS OF USDA OPERATION OF SEDS

IN-HOUSE OPERATION

	<u>First Year</u>		<u>Second Year</u>	
	<u>Own Staff and Equipment</u>	<u>Antenna at Houston</u>	<u>Own Staff and Equipment</u>	<u>Antenna at Houston</u>
Personnel - 15 People	\$ 470,000	\$ 470,000	\$470,000	\$470,000
Equipment	847,000	847,000		
Delivery Service	4,000		4,000	
NOAA Tape Handling	10,763		10,763	
Maintenance	30,000	30,000	30,000	30,000
Own Antenna		350,000		
Data Delivery to Mexico	<u>5,200</u>	<u>5,200</u>	<u>5,200</u>	<u>5,200</u>
Total	\$1,366,963	\$1,702,200	\$519,963	\$505,200

A big factor in this estimate is the cost of a Production Film Converter (PFC). This item costs \$550,000. This is the cost of equipment currently used to process SEDS film. Almost everyone associated with this project agrees that lower cost equipment could be used. The APHIS evaluators felt that a computer printout with actual numerical values in lieu of the photo map representation would be a better planning tool. Under this method of processing, the photo processing could be eliminated from the system. Tentative evaluations indicate that equipment in the \$80,000 range could be used to process the photos if photos are deemed necessary.

The \$390,000 vendor offer is the greatest value. The vendor has both the experienced staff and equipment to process the work. The vendor can achieve economies because the staff and equipment are shared with other revenue-producing contracts. Although the prospect of a better price could be obtained from competitive bids, this was not investigated.

The high cost of an in-house operation rule this approach out as a cost-effective alternative. The technical risks associated with an in-house start-up for SEDS are high. The technical documentation for SEDS is possibly sufficient for experienced personnel who have operated the system from inception. The vendor personnel have broad experience in programming and processing aerospace applications. A long learning period would be needed to bring an outside team to proficiency.

It appears that the only SEDS variable of potential value is temperature. Considering the importance of the many other variables that impact on the screwworm life cycle which have been discussed earlier in this text, it is questionable if a significant financial investment in a system that predicts only temperature will be prudent. Particularly since the system provides only daily averages and does not reflect soil temperatures, but temperatures read at 5 feet above the soil surface.

With regard to documentation available for technology transfer, the document entitled "System Development of the Screwworm Eradication Data System (SEDS) Algorithm" (24), was provided by NASA. This documentation is inadequate for operational transfer of the SEDS system. The requirement for a more thorough document is evidenced by the following observations:

1. It cannot be assumed that those responsible for implementing the system will have access to the several references cited in the document. These references are available at NASA and copies should become part of the total transfer package.

2. There is need for a total system overview chart illustrating the complexity and interrelationships among the several subsystems in an input-processing-output general format. For example, when and how does the SEDS system access the LARSYS classifier programs.

3. There is need for a general flow chart of the application and utility programs used to process the system. A narrative description of the functions performed by each program is necessary.

4. Equipment resource utilization is needed for any technology transfer for operational scheduling and transfer. For transfer of the SEDS system, we would require documentation of core space, duration of runs, tape and disc units and file sizes involved in processing.

5. Computer program listings should be bound with representative output listings, error messages and other characteristic diagnostics associated with processing. The bound program listings should be identified with the same titles shown in the general flow chart.

6. There are instances within the current document where formulae are incomplete or poorly explained. All such expositions should be reviewed for completeness as a stand-alone item. A few examples of this problem are:

- a. (Pp. 2-19) What is denoted by the symbol $\frac{v^2}{4}$ on line 9?

b. (Pp 2-19) Where does the symbol S^2 come from; its use is not defined in the text.

c. (Pp 2-22) In Table 2-VIII, a column entitled "Correlation Coefficients" does not contain correlation coefficients. What do the entries represent?

d. (Pp 2-42) Line 6 contains the variable DDSYN. Is this the appropriate name or a typo (i.e., should be DDSUM)?

7. Appendix A entitled "Operation of E-Disk Program". What is the E-Disk program and where does it fit within the system?

The deficiencies noted above do not necessarily constitute a new workload requirement. From observations made at NASA, it is believed that the required documentation is available. The task is one of careful review, organization and compilation of existing documents into a complete transfer package.

It is conceivable that the ultimate goal of SEDS would be to predict population growth on a seasonal basis for Mexico. The eventual use of such a prediction would allow production and release to be geared for population trends, Jim Webber (23). This envisioned use is a conceptual outline of such a predictor. As stated in the text, the outline is based on multiple inputs which include sterile fly ratios based on Knipling's models (21), historical data, rancher cooperation and weather data input (SEDS).

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It would be extremely difficult to integrate this into an operational program for the following reasons:

1. Dr. Knipling, when developing his model, used a 10 to 1 ratio of sterile to wild flies based on caged studies. Therefore, the results do not relate to wild populations.

2. Although many years will be required to develop the historical data for any given area in Mexico, information is presently being accumulated. The only historical data presently available is contained in the Sherman Report (1966). This data may or may not be accurate in terms of population trends.

3. Detailed information will probably be difficult to gather. It is unlikely that the ranchers in Mexico will be able to collaborate with the Screwworm Program officials to an extent greater than their U.S. counterparts.

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